IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA

IN RE CIGNA CORP. ERISA LITIGATION	)	MASTER FILE: 03-CV-714
THIS DOCUMENT RELATES TO: ALL ACTIONS	)	

DECLARATION OF GERALD D. WELLS, III REGARDING REPORT OF PROFESSOR KRISHNA RAMASWAMY IN SUPPORT OF PLAINTIFFS' MOTION FOR FINAL APPROVAL OF SETTLEMENT AND CERTIFICATION OF SETTLEMENT CLASS

I, Gerald D. Wells, III, declare as follows:

1. I am a member of the firm of Schiffrin & Barroway, LLP, and co-lead counsel for the Plaintiffs in this matter.

2. Attached as Exhibit 1 is a true and correct copy of the Journal of Finance paper entitled "Components of Investment Performance," which is referenced at page 3, footnote 3 in Professor Ramaswamy's report (the "Ramaswamy Report"), attached to Plaintiffs' Motion for Final Approval of Settlement and Certification of Settlement Class as Exhibit C.

2. Attached as Exhibit 2 is a true and correct copy of the Harvard Business School working paper entitled "Company Stock in Pension Plans: How Costly Is It?," which is referenced at page 3, footnote 3, in the Ramaswamy Report, attached to Plaintiffs' Motion for Final Approval of Settlement and Certification of Settlement Class as Exhibit C.

3. Attached as Exhibit 3 is a true and correct copy of Professor Ramaswamy's *curriculum vitae*.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

DATED this 16th day of September 2005, at Radnor, Pennsylvania

Gerald D. Wells, III
SCHIFFRIN & BARROWAY, LLP

Exhibit 1

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COMPONENTS OF INVESTMENT PERFORMANCE*

EUGENE F. FAMA‡

I. INTRODUCTION

THIS PAPER SUGGESTS methods for evaluating investment performance. The topic is not new. Important work has been done by Sharpe [21, 22], Treynor [23], and Jensen [13, 14]. This past work has been concerned with measuring performance in two dimensions, return and risk. That is, how do the returns on the portfolios examined compare with the returns on other "naively selected" portfolios with similar levels of risk?

This paper suggests somewhat finer breakdowns of performance. For example, methods are presented for distinguishing the part of an observed return that is due to ability to pick the best securities of a given level of risk ("selectivity") from the part that is due to predictions of general market price movements ("timing"). The paper also suggests methods for measuring the effects of foregone diversification when an investment manager decides to concentrate his holdings in what he thinks are a few "winners."

Finally, most of the available work concentrates on single period evaluation schemes. Since almost all of the relevant theoretical material can be presented in this context, much of the analysis here is likewise concerned with the one-period case. Eventually, however, a multiperiod model that allows evaluations both on a period-by-period and on a cumulative basis is presented.

II. FOUNDATIONS

The basic notion underlying the methods of performance evaluation to be presented here is that the returns on managed portfolios can be judged relative to those of "naively selected" portfolios with similar levels of risk. For purposes of exposition, the definitions of a "naively selected" portfolio and of "risk" are obtained from the two-parameter market equilibrium model of Sharpe [20], Lintner [15, 16], Mossin [18] and Fama [10, 11]. But it is well to note that the two-parameter model just provides a convenient and somewhat familiar set of naively selected or "benchmark" portfolios against which

* Research on this paper was supported by a grant from the National Science Foundation.
‡ Graduate School of Business, University of Chicago.

the investment performance of managed portfolios can be evaluated
cated later, other risk-return models could be used to obtain benchn
folios consistent with the same general methods of performance e

In the simplest one-period version of the two-parameter model, tl
market is assumed to be perfect—that is, there are no transactions
taxes, and all available information is freely available to everyb
investors are assumed to be risk averse expected utility maximizers wh
that return distributions for all portfolios are normal. Risk aver
normally distributed portfolio returns imply that the expected utili
mizing portfolio for any given investor is mean-standard deviation
In addition, investors are assumed to have the same views about dist
of one-period returns on all portfolios (an assumption usually called "
neous expectations"), and there is assumed to be a riskless asset f, w
borrowing and lending available to all investors at a riskless rate of int

It is then possible to show that in a market equilibrium all efficie
folios are just combinations of the riskless asset f and one portfolio
assets m, where m, called the "market portfolio," contains every asse
market, each weighted by the ratio of its total market value to the total
value of all assets. That is, if $\tilde{R}_m$, $E(\tilde{R}_m)$ and $\sigma(\tilde{R}_m)$ are the one-period
expected return, and standard deviation of return for the market p
m, and if x is the proportion of investment funds put into the riskless
then all efficient portfolios are formed according to[2]

$$\tilde{R}_x = xR_f + (1-x)\tilde{R}_m \qquad x \leqslant 1,$$

so that

$$E(\tilde{R}_x) = xR_f + (1-x)E(\tilde{R}_m)$$
$$\sigma(\tilde{R}_x) = (1-x)\sigma(\tilde{R}_m).$$

Geometrically, the situation is somewhat as shown in Figure 1. Th
b m d represents the boundary of the set of portfolios that only includ
assets. But efficient portfolios are along the line from R_f through m.
below m (that is, $x \geqslant 0$) involve lending some funds at the riskless r
and putting the remainder in m, while points above m (that is, $x < 0$) i
borrowing at the riskless rate with both the borrowed funds and the
investment funds put into m.

In this model the equilibrium relationship between expected return an
for any security j is

$$E(\tilde{R}_j) = R_f + \left[\frac{E(\tilde{R}_m) - R_f}{\sigma(\tilde{R}_m)}\right] \frac{\text{cov}(\tilde{R}_j, \tilde{R}_m)}{\sigma(\tilde{R}_m)} \qquad (\textit{Ex ante} \text{ market line})$$

Here cov $(\tilde{R}_j, \tilde{R}_m)$ is the covariance between the return on asset j and the

1. By definition, a mean-standard deviation efficient portfolio must have the following pr
No portfolio with the same or higher expected one-period return has lower standard devia
return.

2. Tildes (~) are used throughout to denote random variables. When we refer to realized
of these variables, the tildes are dropped.

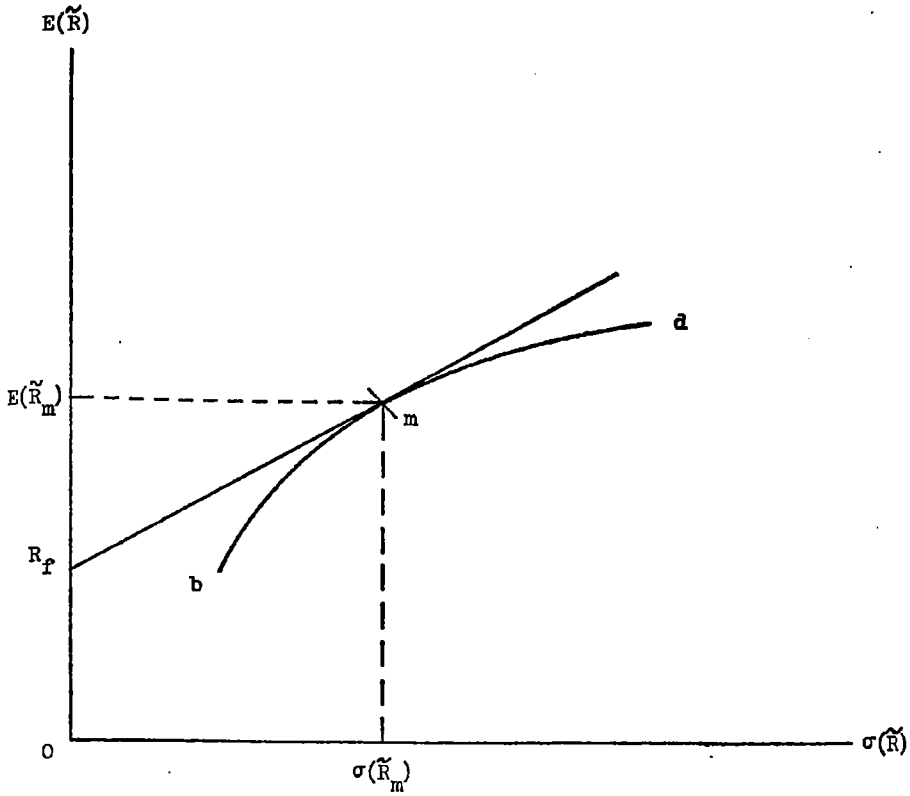

FIGURE 1
The Efficient Set with Riskless Borrowing and Lending

on the market portfolio m. In the two-parameter model $\sigma(\tilde{R}_m)$ is a measure of the total risk in the return on the market portfolio m. Since the only risky assets held by an investor are "shares" of m, it would seem that, from a portfolio viewpoint, the risk of an asset should be measured by its contribution to $\sigma(\tilde{R}_m)$. In fact this contribution is just $\text{cov}(\tilde{R}_j,\tilde{R}_m)/\sigma(\tilde{R}_m)$. Specifically, if x_{jm} is the proportion of asset j, $j = 1, \ldots, N$, in the market portfolio m

$$\sigma(\tilde{R}_m) = \sum_{j=1}^{N} x_{jm} \frac{\text{cov}(\tilde{R}_j, \tilde{R}_m)}{\sigma(\tilde{R}_m)}. \tag{5}$$

In this light (4) is a relationship between expected return and risk which says that the expected return on asset j is the riskless rate of interest R_f plus a risk premium that is $[E(\tilde{R}_m) - R_f]/\sigma(\tilde{R}_m)$, called the market price per unit of risk, times the risk of asset j, $\text{cov}(\tilde{R}_j,\tilde{R}_m)/\sigma(\tilde{R}_m)$.

Equation (4) provides the relationship between expected return and risk for portfolios as well as for individual assets. That is, if x_{jp} is the proportion of asset j in the portfolio p (so that $\sum_{j=1}^{N} x_{jp} = 1$), then multiplying both sides of (4) by x_{jp} and summing over j, we get

$$E(\tilde{R}_p) = R_f + \left[\frac{E(\tilde{R}_m) - R_f}{\sigma(\tilde{R}_m)}\right] \frac{\text{cov}(\tilde{R}_p, \tilde{R}_m)}{\sigma(\tilde{R}_m)} \quad (6$$

where, of course,

$$\tilde{R}_p = \sum_{j=1}^{N} x_{jp}\tilde{R}_j.$$

But (4) and (6) are expected return-risk relations derived under the assumption that investors all have free access to available information and all have the same views of distributions of returns on all portfolios. In short, the market setting envisaged is a rather extreme version of the "efficient markets" model in which prices at any time "fully reflect" available information. (See for example [7].) But in the real world a portfolio manager may feel that he has access to special information or he may disagree with the evaluations of available information that are implicit in market prices. In this case the "homogeneous expectations" model underlying (4) provides "benchmarks" for judging the manager's ability to make better evaluations than the market.

The benchmark or naively selected portfolios are just the combinations of the riskless asset f and the market portfolio m obtained with different values of x in (1). Given the *ex post* or realized return R_m for the market portfolio for the naively selected portfolios, *ex post* return is just

$$\tilde{R}_x = xR_f + (1 - x)\tilde{R}_m, \quad (7$$

that is, (1) without the tildes. Moreover,[3]

$$\beta_x = \frac{\text{cov}(\tilde{R}_x, \tilde{R}_m)}{\sigma(\tilde{R}_m)} = \frac{\text{cov}([1 - x]\tilde{R}_m, \tilde{R}_m)}{\sigma(\tilde{R}_m)} = (1 - x)\sigma(\tilde{R}_m) = \sigma(\tilde{R}_x). \quad (8$$

That is, for the benchmark portfolios risk and standard deviation of return are equal. And the result is quite intuitive: In the homogeneous expectations model these portfolios comprise the efficient set, and for efficient portfolios risk and return dispersion are equivalent.

For the naively selected portfolios, (7) and (8) imply the following relationship between risk β_x and *ex post* return R_x:

$$R_x = R_f + \left(\frac{R_m - R_f}{\sigma(\tilde{R}_m)}\right)\beta_x \qquad (\textit{ex post} \text{ market line}). \quad (9)$$

That is, for the naively selected portfolios there is a linear relationship between risk and return that is of precisely the same form as (4) except that the expected returns that appear in (4) are replaced by realized returns in (9).

In the performance evaluation models to be presented, (9) provides the benchmarks against which the returns on "managed" portfolios are judged. These "benchmarks" are used in a sequence of successively more complex suggested performance evaluation settings. First we are concerned with one-period models in which a portfolio is chosen by an investor at the beginning of the

3. Henceforth the risk $\text{cov}(\tilde{R}_j, \tilde{R}_m)/\sigma(R_m)$ of an asset or portfolio j will be denoted as β_j.

period, its performance is evaluated at the end of the period, and there are no intermediate cash flows or portfolio decisions. Then we consider multiperiod evaluation models that also allow for fund flows and portfolio decisions between evaluation dates. We find, though, that almost all of the important theoretical concepts in performance evaluation can be treated in a one-period context.

III. The Benchmark Portfolios: Some Empirical Issues

Before introducing the evaluation models, however, it is well to discuss some of the empirical issues concerning the so-called "market lines" (4) and (9). Since this paper is primarily theoretical, and since empirical problems are best solved in the context of actual applications, the discussion of empirical issues will be brief.

First of all, to use (9) as a benchmark for evaluating *ex post* portfolio returns requires estimates of the risk, β_p, and dispersion, $\sigma(\tilde{R}_p)$, of the managed portfolios as well as an estimate of $\sigma(\tilde{R}_m)$, the dispersion of the return on the market portfolio. If performance evaluation is to be objective, it must be possible to obtain reliable estimates of these parameters from historical data. Fortunately, Blume's evidence [3, 4, 5] suggests that at least for portfolios of ten or more securities, β_p and $\sigma(\tilde{R}_p)$ seem to be fairly stationary over long periods of time (e.g., ten years), and likewise for $\sigma(\tilde{R}_m)$.

But other empirical evidence is less supportive. Thus throughout the analysis here normal return distributions are assumed, though the data of Fama [6], Blume [3], Roll [19] and others suggest that actual return distributions conform more closely to non-normal two-parameter stable distributions. It would conceptually be a simple matter to allow for such distributions in the evaluation models (cf. Fama [11]). But since the goal here is just to suggest some new approaches to performance evaluation, for simplicity attention will be restricted to the normal model.

Finally, the available empirical evidence (e.g., Friend and Blume [12], Miller and Scholes [17], and Black, Jensen and Scholes [2]) indicates that the average returns over time on securities and portfolios deviate systematically from the predictions of (4). Though the observed average return-risk relationships seem to be linear, the tradeoff of risk for return (the price of risk) is in general less than would be predicted from (4) or (9). In short, the evidence suggests that (4) and (9) do not provide the best benchmarks for the average return-risk tradeoffs available in the market from naively selected portfolios.

Even these results do little damage to the performance evaluation models. They indicate that other benchmark portfolios than those that lead to (9) might be more appropriate, but given such alternative "naively selected" portfolios, the analysis could proceed in exactly the manner to be suggested. For example, Black, Jensen and Scholes [2] compute the risks (β's) for each security on the New York Stock Exchange, rank these, and then form ten portfolios, the first comprising the .1N securities with the highest risks and the last comprising the .1N securities with the lowest risks, where N is the

total number of securities. They find that over various subperiods from 1931-65 the average monthly returns among these portfolios are highly correlated, and when plotted against risk the average returns on these portfolios lie along a straight line with slope somewhat less than would be implied by the "price of risk" in (4) or (9). As benchmarks for performance evaluation models, their empirical risk-return lines seem to be natural alternatives to (9). And with these alternative benchmarks, performance evaluation could proceed precisely as suggested here. But again, for simplicity, we continue on with the more familiar benchmarks given by (9).

It would be misleading, however, to leave the impression that all important empirical problems relevant in the application of performance evaluation models have been solved. To a large extent the practical value of such models depends on the empirical validity of the model of market equilibrium—that is, the expected return-risk relationship—from which the benchmark or "naively selected" portfolios are derived. And though much interesting work is in progress, it would be rash to claim that all empirical issues concerning models of market equilibrium have been settled.

For example, an important (and unsolved) empirical issue in models of market equilibrium is the time interval or "market horizon period" over which the hypothetical expected return-risk relationship is presumed to hold. Does the model hold continuously (instant by instant), or is the market horizon period some discrete time interval? This is an important issue from the viewpoint of performance evaluation since if the market horizon period is discrete, evaluation periods should be chosen to coincide with horizon periods.

The evidence of Friend and Blume [12] and that of Black, Jensen, and Scholes [2] suggests that meaningful relationships between average returns and risk can be obtained from monthly data, while the evidence of Miller and Scholes [17] indicates that this is not true for annual periods. Within these broad bounds, however, the sensitivity of risk-return relations to the time interval chosen remains an open issue.

But unsolved empirical questions are hardly a cause for disheartenment. It is reasonable to expect that some of the empirical issues will be solved in the process of applying the theory. And in any case, application of a theory invariably involves some empirical approximations. The available evidence on performance evaluation, especially Jensen's [13, 14], suggests that the required approximations need not prevent even more complicated evaluation models from yielding useful results.

IV. Performance Evaluation in a One-Period Model When There Are No Intraperiod Fund Flows

Let $V_{a,t}$ and $V_{a,t+1}$ be the total market values at t and $t+1$ of the actual (a = actual) portfolio chosen by an investment manager at t. With all portfolio activity occurring at t and $t+1$, that is, assuming that there are no intraperiod fund flows, the one-period percentage return on the portfolio is

$$R_a = \frac{V_{a,t+1} - V_{a,t}}{V_{a,t}}.$$

One benchmark against which the return R_a on the chosen portfolio can be compared is provided by $R_x(\beta_a)$, which by definition is the return on the combination of the riskless asset f and the market portfolio m that has risk β_x equal to β_a, the risk of the chosen portfolio a. One measure of the performance of the chosen portfolio a is then

$$\text{Selectivity} = R_a - R_x(\beta_a). \tag{10}$$

That is, *Selectivity* measures how well the chosen portfolio did relative to a naively selected portfolio with the same level of risk.

Selectivity, or some slight variant thereof, is the sole measure of performance in the work of Sharpe [21, 22], Treynor [23] and Jensen [13, 14]. But more detailed breakdowns of performance are possible. Thus consider

$$\overbrace{[R_a - R_f]}^{\text{Overall Performance}} = \overbrace{[R_a - R_x(\beta_a)]}^{\text{Selectivity}} + \overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}}. \tag{11}$$

That is, the *Overall Performance* of the portfolio decision is the difference between the return on the chosen portfolio and the return on the riskless asset. The Overall Performance is in turn split into two parts, *Selectivity* (as above) and *Risk*. The latter measures the return from the decision to take on positive amounts of risk.[4] It will be determined by the level of risk chosen (the value of β_a) and, from (9), by the difference between the return on the market portfolio, R_m, and the return on the riskless asset, R_f.

These performance measures are illustrated in Figure 2. The curly bracket along the vertical axis shows *Overall Performance* which in this case is positive. The breakdown of performance given by (11) can be found along the vertical line from β_a. In this example, *Selectivity* is positive: A portfolio was chosen that produced a higher return than the corresponding "naively selected" portfolio along the market line with the same level of risk. *Risk* is also positive, as it is whenever a positive amount of risk is taken and the return on the market portfolio turns out to be higher than the riskless rate.

A. *Selectivity: A Closer Look*

If the portfolio chosen represents the investor's total assets, in the mean-variance model the risk of the portfolio to him is measured by $\sigma(\tilde{R}_a)$, the standard deviation of its return. And the risk of the portfolio to the investor, $\sigma(\tilde{R}_a)$, will be greater than what might now be called its "market risk," β_a, as long as the portfolio's return is less than perfectly correlated with the return on the market portfolio. To see this, note that the correlation coefficient k_{am} between R_a and R_m is

4. For greater descriptive accuracy, we should, of course, say "return from risk" or even "return from bearing risk," rather than just *Risk*. Likewise, "return from selectivity," would be more descriptive than *Selectivity*. But (hopefully) the shorter names save space without much loss of clarity.

$$k_{am} = \frac{\text{cov}(\tilde{R}_a, \tilde{R}_m)}{\sigma(\tilde{R}_a)\sigma(\tilde{R}_m)}.$$

It follows that

$$\beta_a = \frac{\text{cov}(\tilde{R}_a, \tilde{R}_m)}{\sigma(\tilde{R}_m)} = k_{am}\sigma(\tilde{R}_a)$$

so that $\beta_a \leqslant \sigma(\tilde{R}_a)$ depending on whether $k_{am} \leqslant 1$.[5]

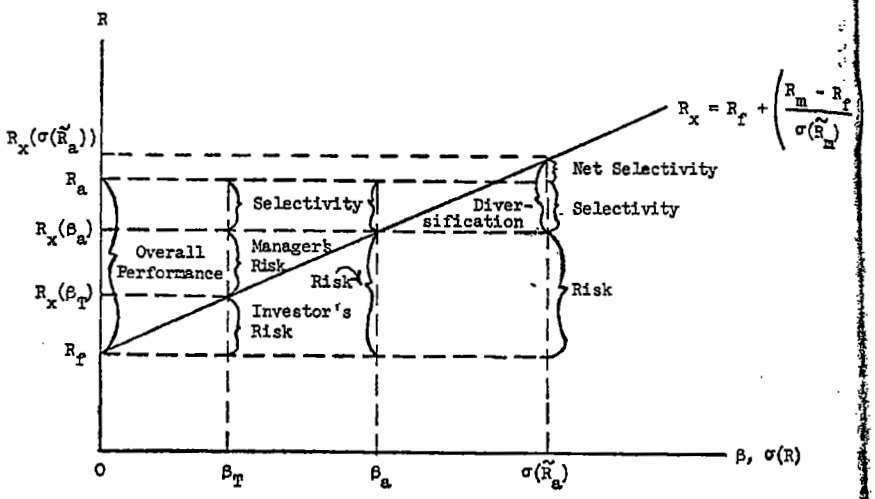

FIGURE 2
An Illustration of the Performance Measures of Equations (11), (12), and (13).

Intuitively, to some extent the portfolio decision may have involved putti more eggs into one or a few baskets than would be desirable to attain portfo efficiency—that is, the manager places his bets on a few securities that thinks are winners. In other words, to the extent that $\sigma(\tilde{R}_a) > \beta_a$, the portfo manager decided to take on some portfolio dispersion that could have be diversified away because he thought he had some securities in which it wou pay to concentrate resources. The results of such a decision can be evaluate in terms of the following breakdown of *Selectivity*:

$$\overbrace{[R_a - R_x(\beta_a)]}^{\text{Selectivity}} = \text{Net Selectivity} + \overbrace{[R_x(\sigma(\tilde{R}_a)) - R_x(\beta_a)]}^{\text{Diversification}}; \qquad (12a$$

or

$$\text{Net Selectivity} = \overbrace{[R_a - R_x(\beta_a)]}^{\text{Selectivity}} - \overbrace{[R_x(\sigma(\tilde{R}_a)) - R_x(\beta_a)]}^{\text{Diversification}}. \qquad (12b$$

By definition, $R_x(\sigma(\tilde{R}_a))$ is the return on the combination of the riskles asset f and the market portfolio m that has return dispersion equivalent

5. In fact the naively selected portfolios are the only ones whose returns are literally perfect correlated with those of the market portfolio (cf. equation (8)). But the theoretical work of Fam [9] and the empirical work of Black, Jensen and Scholes [2] suggests that the return on a well-diversified portfolio will be very highly correlated with R_m.

that of the actual portfolio chosen. Thus *Diversification* measures the extra portfolio return that the manager's winners have to produce in order to make concentration of resources in them worthwhile. If *Net Selectivity* is not positive, the manager has taken on diversifiable risk that his winners have not compensated for in terms of extra return.

Note that, as defined in (12), *Diversification* is always non-negative, so that *Net Selectivity* is equal to or less than *Selectivity*. When $R_m > R_f$, *Diversification* measures the additional return that would just compensate the investor for the diversifiable dispersion (that is, $\sigma(\tilde{R}_a) - \beta_a$) taken on by the manager. When $R_m < R_f$ (so that the market line is downward sloping), *Diversification* measures the lost return from taking on diversifiable dispersion rather than choosing the naively selected portfolio with market risk *and* standard deviation both equal to β_a, the market risk of the portfolio actually chosen.

The performance measures of (12) are illustrated in Figure 2 along the dashed vertical line from $\sigma(\tilde{R}_a)$. In the example shown, *Selectivity* is positive but *Net Selectivity* is negative. Though the manager chose a portfolio that outperformed the naively selected portfolio with the same level of market risk, his *Selectivity* was not sufficient to make up for the avoidable risk taken, so that *Net Selectivity* was negative.

The breakdown of *Selectivity* given by (12) is the only one that is considered here. The rest of Section IV is concerned with successively closer examinations of the other ingredient of *Overall Performance, Risk*. Before moving on, though, we should note that (12) itself is *only* relevant when diversification is a goal of the investor. And this is the case only when the portfolio being evaluated constitutes the investor's entire holdings, and the investor is risk averse. For example, an investor might allocate his funds to many managers, encouraging each only to try to pick winners, with the investor himself carrying out whatever diversification he desires on personal account. In this case *Selectivity* is the relevant measure of the managers' performance, and the breakdown of *Selectivity* of (12) is of no concern.

B. *Risk: A Closer Look*

If the investor has a target risk level β_T for his portfolio, the part of *Overall Performance* due to *Risk* can be allocated to the investor and to the portfolio manager as follows:

$$\overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}} = \overbrace{[R_x(\beta_a) - R_x(\beta_T)]}^{\text{Manager's Risk}} + \overbrace{[R_x(\beta_T) - R_f]}^{\text{Investor's Risk}} \qquad (13)$$

$R_x(\beta_T)$ is the return on the naively selected portfolio with the target level of market risk. Thus *Manager's Risk* is that part of *Overall Performance* and of *Risk* that is due to the manager's decision to take on a level of risk β_a different from the investor's target level β_T, while *Investor's Risk* is that part of *Overall Performance* that results from the fact that the investor's target level of risk is positive. These performance measures are illustrated in Figure 2 along the dashed vertical line from β_T.

Manager's Risk might in part result from a timing decision. That is, in part at least the manager might have chosen a portfolio with a level of risk higher or lower than the target level because he felt risky portfolios in general would do abnormally well or abnormally poorly during the period under consideration. But if an estimate of $E(\tilde{R}_m)$ is available, a more precise measure of the results of such a timing decision can be obtained.[6] Specifically, making use of the *ex ante* market line of (4)[7] we can subdivide *Risk* as follows:

$$\overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}} = \overbrace{\{\underbrace{[R_x(\beta_a) - E(\tilde{R}_x(\beta_a))]}_{\text{Total Timing}} - \underbrace{[R_x(\beta_T) - E(\tilde{R}_x(\beta_T))]}_{\text{Market Conditions}}\}}^{\text{Manager's Timing}}$$
$$+ \underbrace{[E(\tilde{R}_x(\beta_a)) - E(\tilde{R}_x(\beta_T))]}_{\text{Manager's Exp. Risk}} + \underbrace{[R_x(\beta_T) - R_f]}_{\text{Investor's Risk}}. \quad (14)$$

The first three terms here sum to the *Manager's Risk* of (13). *Manager's Expected Risk* is the incremental expected return from the manager's decision to take on a nontarget level of risk. *Market Conditions* is the difference between the return on the naively selected portfolio with the target level of risk and the expected return of this portfolio. It answers the question: By how much did the market deviate from expectations at the target level of risk? *Total Timing* is the difference between the *ex post* return on the naively selected portfolio with risk β_a and the *ex ante* expected return. It is positive when $R_m > E(\tilde{R}_m)$ (and then more positive the larger the value of β_a), and it is negative when $R_m < E(\tilde{R}_m)$ (and then more negative the larger the value of β_a). The difference between *Total Timing* and *Market Conditions* is *Manager's Timing*: it measures the excess of *Total Timing* over timing performance that could have been generated by choosing the naively selected portfolio with the target level of risk. *Manager's Timing* is only positive when the sign of the difference between β_a and β_T is the same as the sign of the difference between R_m and $E(\tilde{R}_m)$, that is, when the chosen level of market risk is above

6. $E(\tilde{R}_m)$ might be estimated from past average returns on the market portfolio m. Alternatively, past data might be used to estimate the average difference between R_m and R_f. In any case, it should become clear that the expected values used must be naive or mechanical estimates (or at least somehow external to those being evaluated), otherwise the value of the timing measures is destroyed.

Admittedly, given the current status of empirical work on the behavior through time of average returns on risky assets, we can at most sepeculate about the best way to estimate $E(\tilde{R}_m)$. Hopefully empirical work now in progress will give more meaningful guidelines. And perhaps the development of theoretical methods of performance evaluation will itself stimulate better empirical work on estimation procedures. In any case, the discussion in the text should help to emphasize that one cannot obtain precise measures of returns from timing decisions without mechanical or naive estimates of equilibrium expected returns.

7. That is,

$$E(\tilde{R}_x(\beta_a)) = R_f + \left[\frac{E(\tilde{R}_m) - R_f}{\sigma(\tilde{R}_m)}\right]\beta_a$$

and similarly for $E(\tilde{R}_x(\beta_T))$.

(below) the target level and R_m is above (below) $E(\tilde{R}_m)$. It is thus somewhat more sensitive than *Total Timing* as a measure of the results of a timing decision.

A target level of risk will not always be relevant in evaluating a manager's performance. For example, an investor may allocate his funds to many managers, with the intention that each concentrates on selectivity and/or timing, with the investor using borrowing or lending on personal account to attain his desired level of market risk.

If a target level of risk is not relevant but the expected value or *ex ante* market line is still available, a breakdown of *Risk* similar to (14) can be obtained by treating the market portfolio (or the appropriate proxy)[8] as the target portfolio. That is,

$$\overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}} = \overbrace{\{\underbrace{[R_x(\beta_a) - E(\tilde{R}_x(\beta_a))]}_{\text{Total Timing}} - \underbrace{[R_m - E(\tilde{R}_m)]}_{\text{Market Conditions}}\}}^{\text{Manager's Timing}} + \underbrace{[E(\tilde{R}_x(\beta_a)) - E(\tilde{R}_m)]}_{\text{Expected Deviation from Market}} + \underbrace{[R_m - R_f]}_{\text{Market Risk}}. \quad (15)$$

The idea here is that even in the absence of a target level of risk, the measure of *Manager's Timing* must be standardized for the deviation of the market return from the expected market return, that is, for the "average" spread between the *ex post* and *ex ante* market lines.

Finally, the goal of this paper is mainly to suggest some ways in which available theoretical and empirical results on portfolio and asset pricing models can provide the basis of useful procedures for performance evaluation. But the various breakdowns of performance suggested above are hardly unique. Indeed any breakdown chosen should be tailored to the situation at hand. For example, if a target level of risk is relevant but the subdivision of Risk given by (14) is regarded as too complicated, then the approximate effects of the timing decision might still be separated out as follows:

$$\overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}} = \overbrace{[R_x(\beta_a) - E(\tilde{R}_x(\beta_a))]}^{\text{Total Timing}} + \overbrace{[E(\tilde{R}_x(\beta_a)) - E(\tilde{R}_x(\beta_T))]}^{\text{Manager's Expected Risk}} + \overbrace{[E(\tilde{R}_x(\beta_T)) - R_f]}^{\text{Investor's Expected Risk}}. \quad (16)$$

The one new term here is *Investor's Expected Risk*, which measures the expected contribution to *Overall Performance* of the investor's decision to have a positive target level of risk. Alternatively if a target level of risk is not

8. For example, if one were faced with portfolio evaluation in a multiperiod context, one might use the average of past levels of market risk chosen by the manager as a proxy for the target risk level when the latter is not explicitly available.

relevant for the situation at hand, but an expected value line is available, Risk can nevertheless be subdivided as follows,

$$\overbrace{[R_x(\beta_a) - R_f]}^{\text{Risk}} = \overbrace{[R_x(\beta_a) - E(\tilde{R}_x(\beta_a))]}^{\text{Total Timing}} + \overbrace{[E(\tilde{R}_x(\beta_a)) - R_f]}^{\text{Total Expected Risk}}. \quad (17)$$

And these few suggestions hardly exhaust the possibilities.

V. Components of Performance: Multiperiod Models with Intraperiod Fund Flows

In the one-period evaluation model presented above, (i) the time at which performance is evaluated is assumed to correspond to the portfolio horizon date, that is, the time when portfolio funds are withdrawn for consumption; and (ii) there are assumed to be no portfolio transactions or inflows and outflows of funds between the initial investment and withdrawal dates, so that there is no reinvestment problem. If in a multiperiod context we are likewise willing to assume that: (i) though there are many of them, evaluation dates nevertheless correspond to the dates when some funds are withdrawn for consumption, and (ii) all reinvestment decisions and other portfolio transactions are also made at these same points in time, then generalization of the one-period model to the multiperiod case is straightforward.[9] Indeed the basic procedure could be period-by-period application of the performance measures presented in the one-period model. The major embellishments would not be in the nature of new theory, but rather would arise from the fact that multiperiod performance histories allow statistically more reliable estimates of the various one-period performance measures.

But this pure case is unlikely to be met in any real world application. Often performance evaluation would be carried out by someone with little or no knowledge of the dates when funds are needed for consumption by the owner of the portfolio, and often (e.g., in the case of a mutual fund or a pension fund) the portfolio is owned by many different investors with different consumption dates. As a result evaluation dates, withdrawal dates, and reinvestment dates do not usually coincide.

The rest of this paper is concerned with how the concepts of the one-period model must be adjusted to deal with such intraevaluation period (or more simply, intraperiod) fund flows. The procedure is to first present detailed definitions of variables of interest in models involving intraperiod fund flows, and then to talk about actual measures of performance. And it is well to keep in mind that though the analysis is carried out in a multiperiod context, the problems to be dealt with arise from intraperiod fund flows. With such fund flows, the same problems would arise in a one-period evaluation model.

A. *Definitions*

Suppose the investment performance of a portfolio is to be evaluated at discrete points in time, but that there can be cash flows between evaluation

9. For the development of the underlying models of consumer and market equilibrium for this case see [8].

value line is available, *Risk*

Total Expected Risk

$$\overbrace{[E(\tilde{R}_x(\beta_a)) - R_f]}. \qquad (17)$$

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dates. That is, there can be intraperiod inflows in the form of either cash receipts (dividends, interest) on existing portfolio holdings or net new contributions of capital by new or existing owners. And there can be intraperiod outflows in the form of dividend payments to the portfolio's owner(s) (e.g., a mutual fund declares dividends) or withdrawals of capital (e.g., by a mutual fund's shareholders).

In simplest terms, the major problem with intraperiod cash flows is obtaining a measure of the return on the beginning of period market value of a portfolio that abstracts from the effects of intraperiod new contributions and withdrawals on the end of period value of the portfolio. One approach is what might be called the mutual fund method. Specifically, when performance evaluation is first contemplated, the market value of the portfolio is subdivided into "shares." Subsequently, whenever there are contributions of new capital or withdrawals of capital from the portfolio, the current market value of a share is computed and the number of shares outstanding is adjusted to reflect the effects of the cash flow.[10]

Thus let evaluation dates correspond to integer values of t and define

$V'_{a,t}$ = actual market value of the portfolio at time t. It thus includes the effects of investment of new capital or reinvestment of any cash income received on securities held in the portfolio, and it is net of any dividends paid out to owners or other withdrawals of funds prior to t.

$V_{a,t}$ = market value the portfolio would have had at t if no dividends were paid out to owners since the previous evaluation date. In computing $V_{a,t}$ it is simply assumed that dividends paid to the portfolio's owners were instead reinvested in the entire portfolio. At the beginning of each evaluation period, however, $V_{a,t}$ is set equal to $V'_{a,t}$.

n_t = number of shares outstanding in the portfolio at t. As indicated above, this is adjusted when new capital comes into the portfolio and when capital is withdrawn, but it is unaffected by reinvestment of cash income received on securities held or by dividends paid to the portfolio's owners.

$p'_{a,t} = V'_{a,t}/n_t$ = actual market value at t of a share in the portfolio.

$p_{a,t} = V_{a,t}/n_t$ = value of a share at t under the assumption that dividends paid to owners of the portfolio were instead reinvested in the entire portfolio.

$R_{a,t} = (p_{a,t} - p'_{a,t-1})/p'_{a,t-1}$. Assuming t corresponds to an evaluation date, this is the one-period return on a share with reinvestment of all dividends paid on a share since the last evaluation date.

$R_{a,t}$ is an unambiguous measure of the return from $t-1$ to t on a dollar invested in the portfolio at $t-1$. This is not to say, however, that it is unaffected by intraperiod fund flows. Such fund flows are usually associated with redistributions of portfolio holdings across securities and these affect the

10. This is in fact the method of accounting used by open end mutual funds. It is also closely related to the "time-weighted rate of return" approach developed by Professor Lawrence Fisher. On this point see [1, Appendix I and p. 218].

return on a share. Moreover, $R_{a,t}$ as defined above is not the only unambiguous measure of the return from $t-1$ to t on funds invested in the portfolio at $t-1$. For example, one could define $R_{a,t} = (p'_{a,t} + d_t - p'_{a,t-1})/p'_{a,t-1}$, where d_t is the dividend per share paid during the evaluation period to the portfolio's owners. The more complicated definition, that is, with dividends assumed to be reinvested, is "purer" (especially for the purpose of inter-portfolio comparisons of performance) in the sense that funds invested at the beginning of a period remain invested for the entire period, but it is less pure in the sense that it assumes a reinvestment policy not actually followed in the portfolio.

The next step is to define prices per share for the benchmark or naively selected portfolios that also take account of intraperiod fund flows.

$p_{xt}(\beta_T)$ = price at t per share of the naively selected portfolio with the target risk level. To avoid double-counting of past performance, at the beginning of any evaluation period (for example, just after an evaluation takes place at $t-1$) this price is set equal to the price per share of the actual portfolio. Then this amount is invested in the naively selected portfolio with the target risk level, and the behavior of the market value of this portfolio during the evaluation period determines the end-of-period price per share, $p_{xt}(\beta_T)$. Any intraperiod cash income generated by the securities of this naively selected portfolio is assumed to be reinvested in this portfolio.

These conventions for the treatment of beginning-of-period values and intra-period cash income will be taken to apply in the definitions of all the benchmark portfolios. Thus

$p_t(R_f)$ = price at t per share of the naively selected portfolio obtained by investing all funds available at $t-1$ in the riskless asset.

The benchmarks provided by $p_{xt}(\beta_T)$ and $p_t(R_f)$ are unaffected by intra-period fund flows in the actual portfolio. This is not true of the following two benchmarks.

$p_{xt}(\beta_a)$ = price at t per share of the naively selected portfolio with market risk equal to that of the actual portfolio. At the beginning of any evaluation period and after any transaction in the actual portfolio during an evaluation period (that is, after any cash flow or exchange of shares in the actual portfolio) the market risk of the actual portfolio is measured, and the current price per share of this benchmark is shifted into the naively selected portfolio with that level of market risk. Thus the value of β_a could be shifting more or less continuously through time as a result of inflows and outflows of funds and decisions to shift the holdings in the portfolio.[11]

11. Indeed even if there are no transactions taking place, the value of β_a shifts continuously through time as a result of shifts in the relative market values of individual securities in the portfolio. Aside from adjusting the value of β_a at the beginning of each evaluation period, we have chosen to ignore the effects of such "non-discretionary" shifts here.

$p_{xt}(\sigma(\tilde{R}_a))$ = price at t per share of the naively selected portfolio with return dispersion equal to that of the actual portfolio. The definition of $p_{xt}(\sigma(\tilde{R}_a))$ is obtained by substituting $\sigma(\tilde{R}_a)$ for β_a in the definition of $p_{xt}(\beta_a)$ above.

Thus $p_{xt}(\beta_a)$ and $p_{xt}(\sigma(\tilde{R}_a))$ take account of changes in β_a and $\sigma(\tilde{R}_a)$ that result from intraperiod fund flows and portfolio shifts. Computationally, keeping tract of β_a and $\sigma(\tilde{R}_a)$ in the way required for these benchmarks is not a difficult problem. At any point in time the market risk β_a of the chosen portfolio is just the weighted average of the market risks of the individual assets in the portfolio, where the weights are the proportions of total portfolio market value represented by each asset. Thus if one has estimates of the market risks of the assets from which portfolios are chosen, the value of β_a is updated by combining these with current measures of the weights of individual assets in the chosen portfolio. And a similar procedure can be followed with respect to updating values of $\sigma(\tilde{R}_a)$.[12]

B. *Multiperiod Measures of Performance*

Given the beginning and end-of-period prices per share for these benchmark portfolios, their one-period returns are obtained in the usual way. Then the performance history of a portfolio can be built up (for example) through period-by-period application of the breakdowns given by (11)-(13). Alternatively, one can define performance measures in terms of profit per share rather than return. Thus, in line with (13) and using end of evaluation period prices, define

$$\overbrace{[p_{a,t} - p_t(R_f)]}^{\text{Overall Performance}} = \overbrace{[p_{a,t} - p_{xt}(\beta_a)]}^{\text{Selectivity}} + \overbrace{[p_{xt}(\beta_a) - p_{xt}(\beta_T)]}^{\text{Manager's Risk}} + \overbrace{[p_{xt}(\beta_T) - p_t(R_f)]}^{\text{Investor's Risk}}. \quad (18)$$

This type of breakdown can of course be computed both period-by-period and cumulatively. And from such multiperiod histories one can get more reliable measures of a portfolio manager's true abilities than can be obtained from a one-period analysis. For example, one can determine whether his *Selectivity* is systematically positive or simply randomly positive in some periods.

For some purposes one may wish to compare the multiperiod performance histories of different portfolios. For example, an investment company may be interested in the relative abilities of its different security analysts and portfolio managers. Or an investor who has allocated his funds to more than one manager may be interested in comparing their performances. On a period-by-period basis such performance comparisons can be carried out in terms of percentage returns. Alternatively, if the prices of shares in different portfolios

12. Keeping track of $\sigma(\tilde{R}_a)$ is especially simple if one assumes that returns are generated by the so-called "market model." On this, and for additional computational suggestions, see Blume [3, 4, 5].

are set equal at the beginning of comparison periods, profit-based performance measures such as (18) could be computed both on a period-by-period basis and cumulatively.

One must not get the impression, however, that all the problems caused by intraperiod fund flows have been solved. Though the performance of a "share" during any given evaluation period (or across many periods) gives an unambiguous picture of the investment history of funds invested in a given portfolio at a given point in time, comparisons of the performances of shares in different portfolios are not completely unambiguous. This is due to the fact that even when things are done on a per share basis, intraperiod fund flows necessitate portfolio decisions that usually have some effect on the performance of a share. And when such fund flows occur at different times (and thus during different market conditions) in different portfolios, the observed performances of shares in the portfolios may differ, even if the portfolios are managed by the same person trying to follow the same policies in all of his portfolio decisions. But though such ambiguities seem unavoidable and to some extent unsolvable, their effects on performance comparisons should be minor except in cases where portfolios experience large cash flows (relative to their total market values) in short periods of time and/or when evaluation periods are long.

Finally, if an *ex ante* market line is available to compute expected values through time for the three benchmarks, $p_{xt}(\beta_x)$, $p_{xt}(\beta_a)$ and $p_{xt}(\sigma(\tilde{R}_a))$, then the one-period performance breakdowns of (14)-(17) can be carried out either in terms of returns or market values, and these can be used as the basis of even more detailed multiperiod performance histories.

But we terminate the discussion at this point. We do this not because of a lack of additional interesting problems, but because in the absence of actual applications, suggested solutions become increasingly speculative and thus of less likely usefulness.

VI. Summary

Some rather detailed methods for evaluating portfolio performance have been suggested, and some of the more important problems that would arise in implementing these methods have also been discussed. In general terms, we have suggested that the return on a portfolio can be subdivided into two parts: the return from security selection (*Selectivity*) and the return from bearing risk (*Risk*). Various finer subdivisions of both *Selectivity* and *Risk* have also been presented.

To a large extent the suggested models can be viewed as attempts to combine concepts from modern theories of portfolio selection and capital market equilibrium with more traditional concepts of what constitutes good portfolio management.

For example, the return from *Selectivity* is defined as the difference between the return on the managed portfolio and the return on a naively selected portfolio with the same level of market risk. Both the measure of risk and the definition of a naively selected portfolio are obtained from modern capital market theory, but the goal of the performance measure itself is just to test how good the portfolio manager is at security analysis. That is, does he show

any ability to uncover information about individual securities that is not already implicit in their prices?

Likewise, traditional discussions of portfolio management distinguish between security analysis and market analysis, the latter being prediction of general market price movements rather than just prediction of the special factors in the returns on individual securities. The various timing measures suggested in this paper provide estimates of the returns obtained from such attempts to predict the market. And modern capital market theory again plays a critical role in defining these estimates.

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Exhibit 2

02-058

Company Stock in Pension Plans: How Costly Is It?

Lisa Meulbroek

Harvard Business School
Soldiers Field Road
Boston, MA 02163

The author gratefully acknowledges the support of Harvard Business School's Division of Research. Email: Lmeulbroek@hbs.edu

Abstract

Employees often hold substantial levels of company stock in their defined contribution pension plans, a practice widely-recognized as risky but nonetheless common in high-tech firms and blue-chips alike. While one might reason that employees willing to take on the increased risk should do so, holding company stock is inefficient for *all* employees, even risk tolerant ones. This paper investigates the extent of company stock ownership within defined contribution pension plans and estimates its cost, finding that employee investors sacrifice an average 42% of their company stock's market value by taking on risk that could otherwise have been "diversified away." Significant losses occur even at levels of company stock ownership that fall within the newly-proposed legislative limits. By matching with cash rather than stock, firms could reduce that lost value, making both employees and the firm better off. Risk tolerant employees who want to "swing for the fences" should instead diversify their portfolios and lever them to the desired risk levels. The findings in this paper call into question the wisdom of requiring or allowing company stock holding within retirement plans.

I. Introduction

The collapse of Enron has dramatically illustrated the risk to employees of investing in company stock. But Enron employees are not alone. Whether compelled to do so or not, many employees in risky high-tech firms and blue chips alike invest heavily in company stock. After the fact, it is clear that Enron employees' investment strategy for their retirement savings was risky, but, in fact, their strategy was costly, independent of the firm's collapse. The implied cost stems from the *type* or risk exposure generated by holding company stock. Employees who hold company stock do not have fully-diversified portfolios, exposing them to firm-specific risk that might otherwise have been "diversified away." Because employee investors earn exactly the same returns as fully-diversified investors, but are exposed to greater risk, holding company stock is inefficient for *all* employees, irrespective of their risk tolerance. Exposure to greater risk without commensurately greater returns leads undiversified (or even partially-diversified) employee investors to value their company's stock at less than its market value. This paper investigates the magnitude of the gap between a stock's market value and its value to employees to determine how much employees sacrifice by investing their retirement savings in company stock.[1]

The optimality, or lack thereof, of employees' pension plan investments has gained importance as employees have assumed greater responsibility for their retirement savings. This transfer in risk from the firm to the employee is a result of the shift from defined benefit pension plans, which obligate firms to pay fixed amounts to retired employees, assuming the investment risk of pension plan savings, to defined contribution plans, where employees choose both how much to contribute to their pension plan and how to invest those contributions, accepting the attendant risk.[2]

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[1] Investing in company stock is widely considered to be risky and employees to be well advised to hold only a small portion of their wealth in company stock. This paper does not focus on the risk level per se. If only that distinguished company stock holdings from any other investment, one might conclude that any employee willing to bear the risk in return for correspondingly high returns should do so. This paper, however, argues that holding company stock is inefficient for *all* employees, risk tolerance aside, because it exposes employees to risk for which they are *not* compensated with correspondingly higher returns.

[2] Poterba, Venti and Wise (1999) report that about 85% of private contributions are to plans in which individuals decide how much to contribute, how to invest plan assets, and how and when to withdraw

But employees' investment choices often fall short of good financial practice. Choi, Laibson, Madrian and Metrick (2001a), for example, find that employer-designated default savings rates and investment funds strongly influence the savings levels of employees, few of whom exploit the opportunity to opt out of such defaults. Benartzi and Thaler (2001) find that employees "diversify" by dividing their contributions equally across all of the investment options offered by the employer, rather than varying their investments by asset type, reinforcing the perception that employees invest suboptimally.[3]

This paper investigates the costs of over-investing in company securities at the expense of diversification, an investment practice that appears suboptimal. This over-investment problem is relevant not only to employees who make defined contribution investment decisions, but also to the firms that sponsor such plans. Defined contribution plans with investments heavily weighted towards company stock have been the source of recent lawsuits, such as that involving Lucent Technologies, which have challenged the notion that the firm's sole responsibility to such plans is to present employees with a number of investments options from which to choose. Litigants have contested both the appropriateness of offered investment opportunities and the practice of encouraging employees to hold company stock. That encouragement may be explicit, by prohibiting employees from selling company stock in their retirement plans, or implicit, by characterizing the firm's stock as a "good investment" or by suggesting that it provides tangible evidence of employee loyalty. The cost of overinvestment is also relevant to the myriad legislative proposals that have appeared in the wake of the Enron debacle. At last count, seventeen different bills are being considered, including the administration's proposal voiced by President George W. Bush in his State of the Union address.[4]

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money (i.e., defined contribution plans). In contrast, 64% of employer contributions were to defined benefit plans.

[3] Benartzi (2001) also addresses the optimality of 401(k) investors' strategies. See Agnew, Balduzzi and Sundén (2000) for another perspective. Brown and Warshawsky (2001), Duflo and Saez (2000), Poterba and Wise (1998), Stabile (1998), Sundén and Surette (1998), and Weisbenner (2001) investigate other aspects of employee investment allocation patterns.

[4] See *Present Law and Background Relating to Employer-Sponsored Defined Contribution Plans and Other Retirement Arrangements Regarding Defined Contribution Plans* (2001)

In this paper, a well-diversified stock portfolio is used as a benchmark against which to assess the cost of holding company stock at the expense of diversification. This method estimates how low the stock price must be in order to provide an employee holding only the company stock with the same risk-return tradeoff by investors who hold well-diversified stock portfolios. The value employees forego by investing in company stock depends on the percentage of their wealth that is invested in the firm, and the firm's total risk and its relation to overall market movements. The more company stock an employee holds, the greater the gap between its market value and value to the employee, and consequently, the greater the loss incurred by the employee. Similarly, the greater the stock's correlation with the overall market, the more implicit "diversification" the employee has and the greater the stock's value to the employee.

The evidence in this paper suggests that the value an employee sacrifices relative to a well-diversified equity portfolio of the same risk can be surprisingly large, averaging 42% of the market value of the firm's stock under reasonable assumptions. Even employees who work for relatively safe "blue chip" firms are significantly worse off by concentrating their wealth in company stock.

The implications of these findings are far-reaching. Because employees sacrifice substantial value by holding company stock, market value alone is a poor way for employees to estimate the current value of their retirement savings. For example, a 401(k) plan with a $1 million market value might be worth only $420,000 to an employee with undiversified holdings. The cost of failing to diversify falls on both employees and the firm. To grant an employee stock worth $42,000, a firm must give the employee stock with a market value of $100,000. In effect, the firm compensates employees in a currency worth less to them than its cost to the firm. Both employees and firm would be better off with cash compensation.

The paper proceeds as follows. Section II reviews the types of employee pension plans that hold company stock, the ways firms regulate the amount of stock ownership in such plans, and prior research on pension plan savings behavior. Section III suggests a method for measuring the effect of risk on the value of company stock to employees.

Section IV uses this metric to estimate the costs associated with holding company stock. Conclusions are presented in Section V.

II. The Causes and Consequences of Employee Investment in Company Stock

The loss of retirement savings by ex-Enron employees echoes the high-profile 1963 bankruptcy of Studebaker, which defaulted on its pension promises to retirees, leaving them destitute. This incident provoked (eleven years later) government intervention in the form of the 1974 Employee Retirement Income Security Act (ERISA), which designated the federal government as the guarantor of firms' pension obligations. Additional regulations of pension funding and investments were also added to prevent firms from abrogating their pension responsibilities entirely, in the knowledge that the government would make good any defaults. One feature of these regulations was that the holding of pension fund assets in company stock was capped at 10% of a firm's pension assets.

Although the response to the Enron debacle includes the sort of anger and indignation precipitated by Studebaker's default on its pension obligations to its employees, the investment risk and decision rights differ between their two pension plans. Studebaker's was a defined benefit pension plan, where the company promised to pay its employees a fixed, pre-specified amount upon retirement. If its pension investments provided insufficient to meet its promised payments to employees, Studebaker was legally obliged to make up the shortfall from other assets. If, on the other hand, the company's pension investments had performed better than expected, it would have been free to keep whatever was in excess of the amount needed to fully fund its promised payments.

In contrast, in a participant-directed defined contribution plan such as the one sponsored by Enron, it is the employees who bear the risk of investment shortfalls as well as reap the rewards associated with increases in value. Employees make the requisite

decisions and, such plans being fully portable, can carry them from job to job without loss in value.[5]

Although in theory investment risk in defined contribution plans is borne entirely by employees, some questions about employer culpability have arisen. Enron is perhaps the most recent, but similar cases have been surfacing for years. A prominent example is Lucent Technologies, against which two employees brought suit in July 2001, alleging breach of fiduciary responsibility following a steep decline in Lucent's stock from a December 1999 height of $82 to a low of $6. The suit questions Lucent's policy of allowing employees to buy company stock in their 401(k) plans (company stock was one of several investments offered by the firm, and roughly 30% of 401(k) plan assets were invested in Lucent stock). Lucent matched every dollar employees contributed to 401(k) plans with $0.66 of Lucent stock (up to a limit) and restricted the sale of this stock until an employee reached the age of 55.[6] Participants in a suit brought against Carter Hawley Hale's profit sharing plan for investing all contributions and employee matching funds in that company's stock at a time when the business was faltering won a settlement for their losses in the bankrupt department store chain.

The debate over whether additional regulation of defined contribution plans is needed is a long-standing one.[7] The 1997 bankruptcy of Color Tile prompted a Department of Labor investigation into the holding of company securities in defined contribution plans.[8] Labor's Advisory Council on Employee Welfare and Pension Benefits Plans distinguishes three basic models of defined contribution plans: the *participant investment model* whereby participants are responsible for and empowered to manage the investment of their own account balances; the *directed match model*, popular among larger

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[5] Although many firms offer both defined benefit and defined contribution plans, the trend is towards defined contribution plans. Participants in a 401(k) plan must be offered a minimum of three investment choices: a money-market fund, a stock fund, and a bond fund. These funds can be run by the firm or they can be outside funds such as those managed by Vanguard or Fidelity.

[6] The case is pending.

[7] See Weisbenner (2001) for a discussion of the desirability of additional regulation.

[8] Color Tile's stock constituted 90% of its defined contribution plan assets. See *PWBA Advisory Council Working Group Report on Employer Assets in ERISA Employer-Sponsored Plans* (1997). The working group was formed in part due to legislation proposed by Senator Barbara Boxer that would limit the amount of employer assets in defined contribution plans to no more than 10% of plan assets.

companies, where by employees control their own contributions, but all or a portion of employer contributions are directed into company stock; and the *sponsor investment model*, whereby the employer (sponsor) retains all investment authority including the ability to invest in company stock.

How employees come to own company stock

Some employee holdings of company stock result directly from firms' plan contributions made in the form of company stock. A Hewitt Associates survey of 401(k) plans reported that two-thirds of employees contribute from 5%-8% of their salaries to 401(k)s, and that 32% of employers match $0.50 to $1.00 of employee contributions, usually up to 6% of employee salary. An additional 19% of employers match employee contributions dollar per dollar. Restrictions on how such funds can be invested are common. Twenty-eight percent out of the 475 plans in the Hewitt survey dictated that matching contributions be invested exclusively in employer stock. Large companies are more likely to be invested heavily in company stock,[9] with 49% of large employers reporting restrictions on investments based on specified age and/or service requirements.[10] Abbott Laboratories, for example, allows employees to direct their own contributions but not the firm's matching or bonus contributions in some of its defined contribution plans. But in its stock retirement program, both the employees' and Abbott's contributions are invested in company stock, with employees free to sell the company stock after age 50 (many firms prohibit employees from selling company stock, often until age 55 or 65 or after retirement). The balance of Abbot's 401(k) plan for the year 2000 was $5.7 billion, of which $4.6 billion (81%) was held in company stock. Contributions made that year totaled $277 million, $82 million, or 30% from Abbott, the remainder from employees.

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[9] Twenty-five of 219 large-company plans surveyed by DC Plan Investment had stock representing 60% or more of plan assets.

[10] According to the Employee Benefit Research Institute (EBRI).

Even when permitted to choose how their contributions are invested, employees frequent elect to invest in company stock rather than diversify their holdings. Coca-Cola's plan, for example, has $1.92 billion in total assets, $1.57 billion of which (81%) is invested in company stock. Fifty-two percent of this $1.57 billion is from contributions over which employees have investment control, 48% from company contributions that must be invested in company stock. That a significant portion of participant-directed funds is invested voluntarily in company stock is dramatically illustrated by Albertson's Employees' Tax Deferred Plan. Albertson's contributes no funds to the plan, participants are under no obligation to hold their funds in company stock, yet 46% of the funds assets are invested in company stock.[11]

Given the employees' voluntary investments in company stock, legislators, at least historically, have been hesitant to impose restrictions. In its 1997 review of company stock holding practices, the Department of Labor's Advisory Council recommended against regulating participant investment plans (plans that allow participants to make their own investment choices), opining that the obligation of adequate diversification rested with participants. As for the other two types of plans under which firms exercise some degree of investment control (i.e. directed match and sponsor investment plans), the advisory council recommended that employees be free to trade as the stock vests or a maximum of five years. At a minimum, the advisory council recommended that participants be permitted to diversify at age 55 in the manner afforded participants in ESOP (Employee Stock Ownership Plans).[12] The report also suggested that plan sponsors provide employees with information about the risk of holding a single, undiversified asset.

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[11] The Savings Accumulation Plan of Agilent Technologies, a spin-off of Hewlett-Packard, has a default deferral for employees of 3% of pretax compensation, unless employees elect otherwise. The company matches 1-1 for first 3% of employee' salary, and $0.50 on the $1.00 for the next 2% of deferred pay. Both employee and employer contributions are made in cash. Employees are fully vested immediately on their own contributions, and quarterly on company contributions and have sixteen investment options. The plan has $2.4 billion in assets; $403 million are in Agilent Technologies stock and $359 in Hewlett-Packard stock (brought with them from HP in the spin-off), together constituting 32% of the fund's assets. Munnell, Sunden and Taylor (2000) report that a typical match is fifty cents on each dollar on employee contributions up to six percent of compensation. Many plans permit employees to make unmatched pre-tax contributions beyond that six percent limit, up to the legislated limit.

[12] An 11-K is the Annual Report for Employee Plans filed with the S.E.C.

None of the advisory council's recommendations have been adopted, but Enron's recent collapse has renewed the call for stronger regulation of defined contribution plans. Seventeen legislative proposals are under current consideration, addressing such issues as the duration of blackout periods (also called lockdowns, when participants cannot control their individual account because of administrative changes), the ability of executives to trade non-retirement-related company stock holdings during blackouts, and employees' freedom to diversify. These issues have attracted interest at the highest levels. President George W. Bush created a Task Force on Retirement Security comprising Treasury Secretary Paul O'Neill, Labor Secretary Elaine Chao, and Commerce Secretary Don Evans, and in his January 29, 2002 State of the Union Address, President Bush announced that he had approved its recommendations. On the issue of diversification, the Task Force recommended that employees have the freedom to diversify into other investments after three years of 401(k) plan participation.[13] Congressman George Miller's Employee Pension Freedom Act reduces that to one year. Senator Kennedy's Protecting America's Pensions 2002 added that employers could either match in company stock or offer company stock as an investment option, but not both.

Other legislative efforts address similar topics, some imposing alternative regulation. The Pension Protection Act (H.R. 3463) would cap company stock ownership to 10 percent of 401(k) holdings (but grandfather such holdings in current 401(k)s); some legislative proposals suggest a 20% limit. The Emergency Worker and Investor Protection Act of 2002 H.R. 3622 would apply a 20% tax to managers' golden parachute payments whenever employees are restricted from selling company stock. Other bills call for greater disclosure of information that affects stock value by firms, and stiffer penalties for non-disclosure, government studies of company stock in 401(k) plans, and more employee financial education.[14]

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[13] The Pension Security Act of 2002 (H.R. 3762) incorporates these provisions.

[14] *Present Law and Background Relating to Employer-Sponsored Defined Contribution Plans and Other Retirement Arrangements Regarding Defined Contribution Plans* (2001) summarizes seventeen legislative proposals related to defined contribution pension plans: the Administration's Proposal, H.R. 3463, the Pension Protection Act (Rep. Deutsch and others), H.R. 3509, the Retirement Account Protection Account of 2001 (Rep. Bentsen), H.R. 3622, the Emergency Worker and Investor Protection Act of 2002 (Rep.

Why employees hold company stock when not required to do so

The risk of limiting one's portfolio to a single stock is considerable. Recall that a portfolio comprised entirely of equity (i.e. a diversified equity portfolio) is normally perceived as a risky strategy. Yet, the average risk to an employee of a NYSE firm with a portfolio consisting only of company stock is *twice* as risky as that all-equity diversified portfolio, and an employee in the average Internet-based firm holding only company stock faces *five* times that risk. Despite the risk, employees continue to hold company stock even when not required to do so. Why?

One answer emphasizes employees' limited investment skills. Benartzi and Thaler (2001), for example, find that participants in defined contribution plans employ a naïve "diversification strategy." Using experimental evidence together with data on asset allocation for a sample of investors in defined contribution plans, they show that investors appear to follow a "1/n" diversification strategy; that is, they place equal amounts across the investment options offered in the plan irrespective of the types of investment options. Benartzi (2001) reports that employees also erroneously extrapolate past performance: employees of firms that experienced the worst stock performance over the last 10 years allocated 10.37% of their discretionary contributions to company stock, employees whose firms experienced the best stock performance 39.7%. That these allocations are not correlated with future performance leads the author to conclude that employees "excessively extrapolate" based on a stock's past performance and interpret the allocation of employer's contributions to company stock as investment advice.

Rangel and others), H.R. 3623, the Employee Savings Protection Act of 2002 (Rep. Bentsen), H.R. 3640, the Pension Protection and Diversification Act of 2002 (Rep. Pascrell), H.R. 3642, the 401(k) Pension Right to Know Act of 2002 (Rep. Bonior), H.R. 3657, the Employee Pension Freedom Act of 2002 (Rep. George Miller and others), H.R. 3669, the Employee Retirement Savings Bill of Rights (Reps. Portman and Cardin), H.R. 3677, the Safeguarding America's Retirement Act of 2002 (Rep. English), H.R. 3692, the Pension Protection and Diversification Act of 2002 (Rep. Jackson-Lee), H.R. 3762, the Pension Security Act of 2002 (Rep. Boehner and others), S. 1838, the Pension Protection and Diversification Act of 2001 (Sens. Boxer and Corzine), S. 1919, the Retirement Security Protection Act of 2002 (Sen. Wellstone), S. 1921, the Pension Plan Protection Act (Sens. Hutchison, Lott, and Craig), H.R. 2269, the Retirement Security Advice Act of 2001 (passed by the House on November 15, 2001), S. 1677, the Independent Investment Advice Act of 2001 (Sens. Bingaman and Collins).

Both Madrian and Shea (2001) and Choi, Laibson, Madrian and Metrick (2001a) find that employees tend to be passive investors and investment behavior differs substantially between employees for whom enrollment in 401(k) plans is automatic and those for whom it is not. Although employees can opt out of 401(k) plans, few choose to do so. Choi, Laibson, Madrian and Metrick (2001b) report that initially about 80% of participants accept both the default savings rate and default investment fund. Even after three years, half of plan participants subject to automatic enrollment continue to contribute at the default rate and invest their contributions exclusively in the default fund. The results in Choi, Laibson, Madrian and Metrick (2001a) confirm that employees are likely to do whatever requires the least effort to follow what the authors call the "path of least resistance," irrespective of the optimal investment policy.[15]

This apparently suboptimal investment behavior in 401(k) plans is consistent with more general research that identifies suboptimal investor behavior. Investing investor portfolios at brokerage houses, Goetzmann and Kumar (2001) reports that the majority of investors are under diversified. Similarly, Polkovnichenko (2001) using US Survey of Consumer Finances data, finds lack of diversification at the household level. Many investors appear to follow the ubiquitous advice to "invest in what you know," acting on the basis of familiarity rather than any true information advantage. Huberman (2001), reports that the shareholders of Regional Bell Operating Companies are drawn disproportionately from the areas in which the RBOCs operate, suggesting that this geographic bias is closely related to the general tendencies of households' portfolios to be concentrated, of employees to own their employers' stocks, and of investors to invest disproportionately in their home country.[16] Consistent with Huberman (2001), Coval and

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[15] See also Duflo and Saez (2000), who present evidence that peer effects play an important role in retirement savings decisions, and Kennickell and Sudén (2001), who report a negative effect of defined benefit plan coverage on non-pension net worth, but find the effect on defined contribution plan such as 401(k) to be insignificant.

[16] For research investigating the extent of home xtent of home bias, see Baxter and Jermann (1997), Cooper and Kaplanis (1994), Dahlquist and Robertsson (2001), French and Poterba (1991), Grinblatt and Keloharju (2001), Grubel (1968), Kang and Stulz (1997), Lewis (1999), and Tesar and Werner (1995). Home bias can be a rational response to information asymmetry among investors. For theoretical work concentrating on rational explanations of the observed home bias, see Brennan and Cao (1997) and Gehrig (1993).

Moskowitz (1999) find evidence of geographic bias in portfolio of domestic stocks.[17] According to CBS MarketWatch.com: "More than 85 percent of employees don't have the time, knowledge, or desire to invest their 401(k) assets properly. So they take the path of least confusion—rather than making a mistake in selecting mutual funds, they load up on stock in their company, which at least they know and understand."[18]

The recent, long-running bull market has likely exacerbated employees' tendencies to "invest in what they know." The *Wall Street Journal* describes the eagerness of AT&T employees to risk their life savings (and more) on its wireless unit's April 2000 IPO.[19] AT&T's cost-cutting measures, 25,000 jobs eliminated to date with more reductions expected, which only exacerbate employees' exposure to firm-specific risk, have not stemmed the rush to bet the ranch on the IPO. "People who are looking at this IPO may not have jobs," remarked on employee. Yet executives and lower-level employees alike scrambled to buy IPO shares. One person's advice: "Sure, you can focus on the what-ifs. What if you lose your money? But what if you doubled or tripled your money?" Perhaps the tales of founders and managers of start-up firms who have become millionaires through stock acquired from grants or options inspires employees to think that their holdings will do the same for them.[20]

Another explanation advanced for employees' voluntary holding of company stock is their failure to grasp the risk of such a strategy. A 1999 survey by John Hancock of 801 defined contribution plans reported that employees erroneously view company stock ownership as considerably less risky than investment in a diversified stock fund. These

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[17] Of course, finding the optimal allocation is difficult even for investment professionals (as evidence, consider the number of professionals who fall into the trap of "time diversification"; that is, the belief that stocks are less risk over a long investment horizon—see Bodie (1995)).

[18] CBS.MarketWatch.com was citing the results of a Forrester Research study.

[19] One employee borrowed $42,600 from his retirement account and took an $11,800 loan from his credit union (which summed to an amount greater than his annual salary) to invest in the IPO. Other employees cashed in on their 401(k) plans and took loans against their credit cards. See Blumenstein (2000).

[20] Employees (at least when considering employees as a whole and not restricting attention to officers and directors) do not appear to have any specific investment or timing ability when it comes to their own stock. Benartzi (2001) find that employees' allocations to company stock do not predict future performance.

respondents' perceived risk of company stock has declined and their perceived risk of diversified stock funds risen significantly since 1995.[21]

Employees appear to receive little specific advice from their firms on the risks of company stock holding. Although proscribed from offering direct investment guidance to plan participants, employers can hire independent firms that provide advice, but not money management, or deputize their plan providers to offer "education," general guidance without specific investment recommendations. Independent firms contracted to do this work, however, are extremely reluctant to make recommendations about company stock holding for fear of offending sponsoring firms. TeamVest, for example, a joint venture with Quicken.com, advises participants in 401(k) plans about investments, but does not make buy or sell recommendations for company stock. It does, however, tell participants when stock concentrations might violate the generally accepted principles of asset allocation (which are interpreted to mean that no single investment should constitute more than 10% of a portfolio).[22]

Why employers give, require, or encourage employees to hold company stock

If holding company stock is risky, why do employers require or encourage employees to do so? One possibility is incentive-alignment, although it is far from clear that broad-based ownership of stock in 401(k) plans improves firm performance given that most employees have little personal influence on stock price. A weak connection between effort and stock price dampens the potential incentive effects of stock ownership. So even if stock and option plans are an effective way to align top managers' incentives with those of shareholders, stock ownership by mid- or low-level employees may not be as productive. A related possibility is loyalty, but again one wonders whether broad-based

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[21] "John Hancock Financial Services Sixth Defined Contibution Plan Survey," (1999).

[22] As Bajtelsmit and VanDerhei (1997) succinctly put it: "It is doubtful that plan participants fully realize the extent of the risk they assume in investing in company stock and, for obvious reasons, it is even more doubtful that any employer is going to tell them not to do so."

stock ownership will have the same effect on employees as on top management and whether there might be less expensive ways for firms to generate loyalty.[23]

One must also question whether employers understand the full cost of granting company stock. Anecdotal evidence suggests not. A spokesperson for Gillette Co. discussing the advantages of employee ownership explained: "We believe 401(k) [plans] are a long-term investment, and we believe that Gillette stock is an excellent long-term investment." Francis (2001) reports approximately 48% of 401(k) assets at Gillette are invested in company stock). Proctor & Gamble employees, according to spokeswoman Vicky Mayer, see P&G stock as a good long-term investment because "it's the leader in its industry."[24] Because P&G employees are required to invest only in P&G stock until age 50, at which point they can diversify, 96% of the company's plan assets are invested in company stock. Remarked Reuben Mark, CEO of Colgate-Palmolive, which has 80% of its 401(k) plan assets in company stock: "One school of thought says don't put all of yours eggs in one basket. Another says, put them in one basket but watch it pretty closely. Our people feel they know the company well; they are involved in it and working their tails off to be successful so they feel comfortable investing in Colgate stock."[25]

Such remarks and observations suggest that top managers might not be fully cognizant of the *nature* of the risk to which company stock holdings expose employees. The risk associated with holding company stock is not only higher than that associated with holding a diversified portfolio, but is also inefficient and costly. Even employees who are relatively risk tolerant and willing to bear the high level of risk associated with holding a single stock incur a substantial cost insofar as they bear the firm's total risk, but are not compensated for that risk with higher expected returns. Such employees would be better off (have a higher expected return) by holding diversified portfolios and levering up to the company stock's volatility level. Adding to the costs associated with

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[23] Ippolito (1997) argues that 401(k) plans could help a firm sort its employees by inclination to save, a sorting that presumably could help the firm select workers for jobs and encourage savers to stay with the firm.

[24] As quoted in Braham (2001).

[25] Blake (2001).

holding company stock are other factors that cause employees to be even more undiversified than their stock holdings suggest. Specifically, their continued employment and its relation to the fortunes of the firm, outstanding deferred compensation owed to the employee,[26] and any firm-specific human capital,[27] exacerbate employees' firm-specific risk exposure.

For those who maintain that investing in a single company is the only way to achieve wealth, expressed above by the AT&T employee, the analogy to a lottery ticket seems apposite. Although one might, indeed, strike it rich by buying one, a lottery ticket is not an actuarially fair bet and certainly not a good financial planning device. One purpose of this paper is to illustrate how costly a single-stock bet is.

Employees who believe they are investing cautiously because their employer is a well-known, long-standing firm with successful products need only look to blue-chip P&G to see just how risky their company stock is. In the first quarter of 2000, AA-rated P&G stock fell 50%, meaning that over the course of a few weeks employees' retirement savings (almost entirely invested in P&G stock) were halved. Even Enron's debt was rated BBB+ (investment grade) before the firm collapsed. As CnnMoney observed: "Reformists argue there should be a limit to the amount of company stock in your 401(k) because it's too dangerous to concentrate your retirement money in just one investment. It's a tragedy waiting to happen, they say. You might think your company's stock is great, but that's what Enron employees thought a year ago" (58% of Enron's 401(k) assets were invested in company stock).

High-level managers appear to better understand the costs associated with their own holdings of company stock and options, officers and directors in volatile firms being especially quick to exercise options and sell stock. Meulbroek (2000) finds that

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[26] Deferred compensation, being a general liability of a firm, exposes employees to firm-specific risk.

[27] Friend and Blume (1975) estimate that, on average individuals' human capital (including the value of any privately owned businesses) constitutes 52% to 87% of their total assets; some portion of that human capital will no doubt be specific to a firm. If the fate of the firm is to that of its industry, its employees' job prospects (at least those in the same industry) might suffer when the firm's fortunes are poor, increasing the magnitude of their exposure to the firm's risk. See Degeorge, Jenter, Moel and Tufano (2000) for a discussion of employees' human capital affects their decisions to buy their employer's stock.

managers at Internet-based firms sell their company stock at a higher rate than managers at other firms; corporate transactions in Internet-based firms consist overwhelmingly of sales (92% of all transactions). Managers in less-volatile, non-Internet-based firms have a much lower proportion of sales-to-purchases (59%). Moreover, managerial transactions in Internet-based firms tend to be larger than those in other firms ($2.0 million versus $418,000 per transaction), suggesting that managers in this set of firms are well aware of the risk exposure created by their lack of diversification.[28] Consistent with these results, Ofek and Yermack (2000) report that executives, when they exercise their options to acquire stock, sell nearly all of their acquired shares. They also find that managers who have high ownership stakes offset the impact of stock received as compensation by selling previously owned shares. Yet, despite these actions, most officers and directors remain relatively undiversified.

III. The Value of Company Stock to Employees

That employees who hold only company stock expose themselves to a level of risk much higher than that borne by a fully-diversified investor is clearly illustrated in Table 1. Wealth invested solely in the average NYSE firm, for example, exhibits annual volatility of 45%, more than twice that of the 22% annual volatility exhibited by an all-equity, diversified market basked of stocks. Undiversified investors in volatile, Internet-based firms face even higher risk, on average *five* times the risk borne by diversified investors (the volatility of Internet-based firms averages 117%).

Perhaps even more important than the increased *level* of risk is the *type* of risk exposure engendered by lack of diversification. Specifically, no "compensation" is received for carrying excessive risk that could easily have been "diversified away." To adequately compensate undiversified employee investors, the expected return on

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[28] The market appears to recognize that lack of diversification, combined with the high volatility of Internet-based firms and limited control they have over that volatility, gives managers an incentive to diversify by selling their stock holdings, irrespective of their beliefs about the accuracy of the current stock price. Stock sales by managers in Internet-based companies do *not* produce negative excess returns (the mean return on an insider selling day is +0.82%, net-of-market movements, for an Internet-based firm), which contrasts with the effect of such sales in the general population of firms.

company stock would need to be commensurate with its *total* volatility, not just its systematic risk component. Because expected returns are instead set by a firm's incremental contribution to the volatility of the market portfolio, and *not* the total volatility, such returns are too low to fully compensate employees for their risk exposure. The greater the amount of wealth tied up in a stock firm, the greater the lost diversification cost incurred.

Is the difference between the market value of company stock and its value to an undiversified employee investor significant? How can the cost of lost diversification be measured? One approach is to ask how great a return undiversified employee investors would need to be indifferent to holding only their firm's stock versus holding an efficiently diversified portfolio levered to a volatility equal to that of the firm's stock. Put another way, what price would be low enough to provide employees holding only company stock with the risk-return tradeoff embedded in the market (i.e., the market's Sharpe ratio)?

This method, which parallels one presented in Meulbroek (2001b) for valuing managers' option-based compensation, should yield an upper-bound on the private value of company stock to employees, because the actual value of company stock depends not only on employees' level of diversification, but also on their specific risk preferences. The level of risk that accompanies excessive company stock holdings, for example, might not be the employee's preferred level, even if she were to receive the risk-return ratio (Sharpe ratio) embedded in the market. The only way to measure the additional discount to market value applied by undiversified employee investors is to know their individual preferences, that is, their utility functions.

This paper does not attempt to measure the additional costs created by employee-specific risk preferences, focusing instead on the cost common to all employee, namely, the cost of lost diversification.[29] Estimating an employee's utility function and parameters is a difficult task, impractical when setting policy for a firm with thousands of

[29] For examples of this individual, utility-based technique as applied to valuing managers' option-based compensation, see Detemple and Sundaresan (1999), Hall and Murphy (2000), Hall and Murphy (2002), Huddart (1994), Jin (2001), Kahl, Liu and Longstaff (2001), and Lambert, Larcker and Verrecchia (1991).

employees. Moreover, the costs engendered by risk preferences could, in principle, be reduced through financial engineering or employees' ability to choose employers and, by extension, the type of compensation package or pension plan they receive. But the only way to reduce the cost that results from lack of diversification is to diversify.

The value of company stock when employees are completely undiversified

We begin with the assumption that CAPM holds instantaneously in a continuous-time model, an assumption consistent with the underlying assumptions of the Black-Scholes option-pricing model that we use later to value executive options.[30] (This assumption is not critical in the sense that the same method presented here could be adapted to incorporate any asset-pricing model (the numerical estimates might change, but the technique will not)).

The assumptions produce mean-variance behavior. Interpreted in the context of this paper, mean-variance behavior implies that even people with high risk tolerance prefer the higher expected return produced by a leveraged, fully-diversified portfolio to the lower expected-return from an equally-risky single-stock portfolio.

In the Black-Scholes model, and in continuous-time portfolio theory, the security market line relation is expressed in "instantaneous" expected-rates-of-return (i.e., exponential, continuous-compounding):

$$r_j = r_f + \beta_j \left(r_m - r_f \right) \tag{1}$$

where:

[30] Unlike the original, single-period, discrete-time version of the CAPM, the continuous-time version with its implied mean-variance optimizing behavior is consistent with limited-liability, lognormally-distributed asset prices and concave expected utility functions. See Merton (1992) and Black and Scholes (1973) on the CAPM in continuous time. Combining a continuous-time approach with log-normally distributed security returns yields mean-variance behavior without imposing the strict assumptions that limit the utility function to quadratic utility and normally distributed prices, as does the discrete time model.

$e^{r_f} \equiv (1+R_f)$ where R_f represents the riskless arithmetic return, and r_f is therefore its continuously compounded equivalent.

$e^{r_j} \equiv$ (1 + yearly expected rate-of-return of stock j under CAPM pricing)

$e^{r_j^u} \equiv$ (1 + yearly expected rate of return on stock *j* required by an *undiversified* mean-variance optimizing investor to make that investor indifferent to holding stock *j*, or holding a market portfolio with a volatility equal to that of stock *j*)

$(r_m - r_f) \equiv$ the market's risk premium (continuously-compounded)

$r_m =$ the expected market return (continuously-compounded)

$\sigma_m =$ the market's volatility

$\beta_j =$ firm *j*'s beta from CAPM

$\sigma_j =$ firm *j*'s volatility

Define $s_j \equiv r_j^u - r_j$ as the instantaneous spread between the expected return required by an undiversified investor relative to the CAPM-based expected return. This spread represents the compensation an undiversified investor must receive in order to be indifferent to holding only stock *j* or holding the market portfolio.

To estimate r_j^u at each point in time we examine the volatility level associated with the employee's concentrated holdings and ask what expected return on stock *j* would make the employee indifferent to holding stock *j* or the best possible portfolio.

An undiversified investor who had the market portfolio as an alternative investment opportunity, and was a mean-variance efficient investor, would require a risk-return ratio as good as the market's risk-return ratio in order to be indifferent to holding the market portfolio,or a portfolio composed exclusively of stock *j*. To calculate the excess return

commensurate with stock j's risk-level, r_j^u, using the market's risk-return ratio as a benchmark we use the Sharpe ratio:

$$\frac{r_m - r_f}{\sigma_m} = \frac{r_j^u - r_f}{\sigma_j} \quad \Rightarrow \quad r_j^u = r_f + \left[\frac{\sigma_j}{\sigma_m}\right](r_m - r_f) \tag{2}$$

Knowing r_j^u and r_j yields s_j $(s_j \equiv r_j^u - r_j)$.

$$s_j = \left(\left[\frac{\sigma_j}{\sigma_m}\right] - \beta_j\right)(r_m - r_f) = \left[\frac{\sigma_j}{\sigma_m}\right](1 - \rho_{jm})(r_m - r_f) \tag{3}$$

where ρ_{jm} is the correlation coefficient between firm j's returns and the market returns. Thus, s_j represents the added return required to compensate the undiversified employee for the added risk associated with holding only stock j. We translate this return into a dollar amount as follows.

Let $V_j(t) \equiv$ the value of stock j at time t (the market price).

$T \equiv$ the date at which the undiversified employee is free to sell the stock.

$V_j^u(t) \equiv G(V_j(t), \tau, d_j, s_j)$, which is the private value placed on stock j by an investor who holds that stock position, undiversified, until date T, where $\tau \equiv T - t$.

In the analysis that follows we assume for analytical simplicity that the firm does not pay dividends during $t \le T$, the employee's holding of company stock.

By definition of r_j we know that the discounted expected future value of firm j at time T equals today's stock price.

$$V_j(t) = e^{-r_j \tau} E_t\{V_j(T)\} \tag{4}$$

where $E_t\{\bullet\}$ is the conditional expectation of the value of the shares of j at T, conditional on the information available at time t. Similarly, by definition of r_j^u we know that the

expected future value of the firm to the undiversified investor discounted by r_j^u is the value of the firm today to that investor.

$$V_j^u(t) = e^{-r_j^u \tau} E_t\{V_j^u(T)\} \quad (5)$$

T is the date at which undiversified investors are free to sell their shares in the open market (think of T as being either the time at which prohibitions against selling the company stock expire (e.g., upon retirement or reaching 55 years of age), or the time at which recognition that lack of diversification is risky prompts the employee to sell the stock). At date T, for every outcome the value of the stock to the undiversified investor, $V_j^u(t)$, will equal the market value of the firm: [31]

This statement must hold expectationally as well:

$$E_t\{V_j^u(T)\} = E_t\{V_j(T)\} \quad (6)$$

Substituting (6) into (4) and (5), we have

$$V_j^u(t) = e^{-r_j^u \tau} E_t\{V_j(T)\} = e^{-r_j^u \tau} \cdot e^{r_j \tau} \cdot V_j(t) = e^{-s_j \tau} V_j(t) \quad (7)$$

The employee's private value of the stock today is its market value today, discounted by the incremental amount required to compensate the employee for the firm's total risk. $\mathcal{E}$, below, is the percent value that remains after adjusting the stock's market value for risk.

[31] This assumption rules out the possibility of asymmetric information that would result in a departure of the firm's market value from its fundamental value. We do this to focus attention on the structural problems associated with loss of diversification. This assumption has the potential to affect our estimates of efficiency if we think information asymmetry exists and informed investors try to profit by their information by choosing to work at firms whose stock they believe to be undervalued by the market, hoping to be compensated in a security that they know to be worth more than its market price. It would be unlikely, however, that all investors who believed these stocks to be undervalued not only possessed the proper skill sets to work at such firms, but also viewed doing so as the most productive use of their skills. Indeed, even if the informed investors did possess the appropriate skill sets, simply buying the stock would be a more direct (and lower-cost) method of profiting from their information. Finally, structuring a retirement plan around the assumption (or hope) that employees know the firm to be undervalued hardly seems a wise strategy.

$$\Rightarrow \varepsilon \equiv \%\ \text{Value Remaining After Risk Adjustment} = \frac{V_j^u(t)}{V_j(t)} = e^{-s_j \tau} \qquad (8)$$

The value of company stock when employees are partially-diversified

The efficiency measures outlined above assume that employees hold *all* of their wealth in company stock and are therefore completely undiversified. Although this assumption might be a good approximation for some employees, one expects that many employees have at least some additional assets. This outside wealth reduces employee risk exposure by "diversifying away" some of the company's stock's risk. Under partial diversification the volatility employees face will be a mix of the firm's volatility and the volatility of their other holdings and, as a consequence, the premium required by an individual employee, s_j, will decrease. If we assume that partial diversification is achieved by investing some holdings in the market portfolio (scaled by the riskless asset) we can derive the value of company stock to a partially-diversified employee with the same Sharpe-ratio-based technique used to value company stock to fully-diversified employees. For a partially-diversified investor with weight w invested in stock j and (1-w) in the market portfolio, ε^*, the proportion of stock value remaining after accounting for the employee's partial diversification is:

$$\varepsilon^* = \frac{V_j^*(t)}{V_j(t)} = e^{-\left(r_j^* - r_j\right)\tau} \quad , \text{ where } r_j^* - r_j = \left[\frac{1}{w}\left[\frac{\sigma_p - \sigma_m}{\sigma_m}\right] + \left(1 - \beta_j\right)\right]\left(r_m - r_f\right)$$

where σ_p equals the standard deviation of the combined market plus stock j portfolio and can be calculated as

$$\sigma_p = \sqrt{w^2\sigma_j^2 + (1-w)^2\sigma_m^2 + 2w(1-w)\sigma_{jm}} = \sigma_m\sqrt{w^2\left(\frac{\sigma_j}{\sigma_m}\right)^2 + (1-w)^2 + 2w(1-w)\beta_j}$$

IV. Estimating the Value Sacrificed by Employees Who Hold Company Stock

To better illustrate the economic significance of the cost of holding company stock, this section presents the risk-adjusted measures derived above for a broad sample of firms. Specifically, we calculate the ratio of employees' stock values (i.e., the value of stocks to investors who are not fully diversified) to the market values of the stocks for all NYSE, AMEX, and NASDAQ firms listed as of December 31, 1998, and examine separately the results for a sample of Internet-based firms defined by the Hambrecht & Quist (H&Q) *Internet Index*.[32] We then repeat the analysis, this time assuming the employee to be only partially, rather than completely, undiversified. Finally, we use pension fund data that describes the holdings of company stock relative to a pension plan's total assets to assess how much value is lost per firm based upon the plans' company stock holdings.

These calculations require estimates of β and σ for each firm as inputs. To estimate a firm's β, we use the market model, incorporating the last 150 trading days of returns data prior to December 31, 1998 and using CRSP's value-weighted market composite index. We use these same 150 trading days of returns data to estimate individual firms' σ. To estimate the market's volatility, σ_m, we use the returns of CRSP's value-weighted market composite index over this same time period. We assume a risk-premium of 7.5% (7.2% continuously-compounded), the historical average amount by which the value-weighted market index exceeds the long-term government bond rate (monthly data begins in 1926).

To examine these results at the industry level, we use the firms listed in Value Line's *Investment Survey* as of December 31, 1998. We also examine separately the results for a sample of Internet-based firms defined by the Hambrecht & Quist (H&Q) *Internet Index*. The latter is used because Value Line's coverage is limited to six firms during the period over which we conducted our examination. Internet-based firms are of particular interest

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[32] We use 1998 data because that is the latest year of pension data presented in the upcoming tables (companies file Form 5500 with a considerable lag). The H&Q *Internet Index* comprises a subsample of Internet-based firms not confined to H&Q clients. The *Internet Index* is widely cited and viewed as a reliable reflection of Internet-based activity.CRSP securities corresponding to ADRs (American Depository Receipts), foreign incorporated companies, REITS (Real Estate Investment Trusts), and closed-end mutual funds are not included in the analysis.

because of their high volatility and because we expect their employees' company stock holdings to be relatively high. Value Line's industry classifications are widely held to be more accurate than those implicit in the SIC codes. The database of firms and industry classifications used in this paper are described in Stafford (2001); we have updated that database through year-end 1998.[33] The Stafford-Andrade Value Line data lists all firms and industry assignments collected from fourth quarter editions of Value Line, excluding foreign industries (e.g., "Japanese Diversified" or "Canadian Energy"), ADR's, REIT's, investment funds, and firms with industry classifications of "unassigned" or "recent additions" that are not subsequently assigned to an industry by Value Line. The database uses Value Line's industry classifications with a few exceptions. Industries, for example, differ merely by geographic classifications (e.g., "Utilities (East)" and "Utilities (West)") and in which product lines seem quite similar (e.g., "Auto Parts (OEM)" and "Auto Parts (Replacement)") are merged into single categories. Our sample comprises 1,496 Value Line firms classified into 56 industries.

Data on the amount of company stock in a firm's defined contribution pension plans comes from Form 5500, the Annual Return/Report of Employee Benefit Plan, filed with the IRS and Department of Labor.[34] ERISA (Employee Retirement Income Security Act) requires that each qualified retirement and employee welfare benefit plan as well as other deferred compensation plans file annually a report on the plans' financial conditions and operations. This report must be filed on Form 5500 within seven months after the close of the plan year. There is a considerable lag between plan years and data availability. We used the latest date available as of September 2001, which corresponds to the 1998 Plan Year. Nonpublic firms and individuals, who file many of the Form 5500s, are not included in our sample. We also restrict the sample to firms with defined contribution pension plans.[35]

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[33] The author thanks Gregor Andrade and Erik Stafford for the use of this database.

[34] This form is required to be filed under sections 104 and 4065 of the Employee Retirement Income Security Act of 1974 (ERISA) and sections 6039D, 6047(e), 6057(b), and 6058(a) of the Internal Revenue Code.

[35] Petersen (1994) describes Form 5500 data in greater detail.

Form 5500 identifies sponsoring firms by EIN (employer identification number) and (less frequently) CUSIP. To match each plan with stock price data, we match the Form 5500 EIN to Compustat's EIN and find the corresponding CUSIP and CRSP Perm. When possible, we use the Form 5500 CUSIP to match the plan directly to CRSP stock price data. Because many firms have more than one defined contribution pension plan, we aggregate the holdings across each CRSP PermCo. We crosscheck the name of the firm with the name of the pension plan to weed out inaccurate matches, mindful that names might not match even for accurate matches because acquired firms' plan names are generally retained.

Table 1 compares the annual volatilities for each firm listed in CRSP with the volatility of a well-diversified equity portfolio (the CRSP value-weighted market composite index). The data in Table 1 indicate that the risk difference between holding a single stock and a diversified portfolio is quite large. The average NYSE firm, for example, has twice the volatility of the well-diversified portfolio; the average NASDAQ firm has three and one-half times the volatility of a well-diversified equity portfolio. The final column in Table 1 estimates the proportion of a firm's risk that could be eliminated through diversification.[36] Because most volatility is firm-specific rather than systematic, diversification has the potential to eliminate most of a firm's risk. Without such diversification, the risk of holding a firm's stock is substantially higher.

Table 2 displays characteristics of the pension plan data. In our sample, 3,723 firms can be matched to at least one pension plan, and there are a total of 5, 657 plans, for an average of 1.5 plans per firm, and total assets of $726 billion.

Table 3 provides information on the proportion of assets invested in company stock. For firms that invest at least some defined contribution assets in company stock, company stock constitutes 27% of total assets and approximately 4% of equity value is held by

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[36] Estimated using a market model regression for firm j: $\tilde{R}_{jt} = \alpha_j + \beta_j \tilde{R}_{mt}$ where the R^2 from the regression model represents the proportion of the variance of firm returns that can be attributed to $\beta_j \tilde{R}_{mt}$ and 1-R^2 is the proportion of the variance explained by the disturbance, which represents the portion of risk that is firm-specific and unrelated to market movements.

employees in their defined contribution plans.[37] For larger firms, this number is likely to be even higher: the Profit Sharing/401(k) Council of America 42nd annual survey states that for plans with more than 5,000 participants, an average of 49% of plan assets is invested in company stock.

Table 4 illustrates for each Value Line Industry how much employees sacrifice by holding company stock. These estimates are hypothetical in the sense that they do not employ pension plan data, but rather they use a firm's volatility and risk level to show how lack of diversification affects the stock's value to an undiversified investor. The calculations are based on the assumption that all of the employees' assets are invested in defined contribution plans and the employees hold their company stock for time periods that range from three to fifteen years. The higher end of this holding period is probably reasonable, given that many firms require employees to hold company stock (at least that portion that comes from matching funds) until age 50 or older. The "Extra Return Needed to Compensate for Risk," the S_j from equation (8), represents how large an expected return (over and above the expected return as calculated via the CAPM) is required to compensate employees' exposure to both firm-specific and market risk. The lower the total risk of the firm and the higher the correlation between the firm's returns and market returns, the lower this premium. The premium required is highest for firms in Internet-based, Oilfield Services & Equipment, Textiles, and Precision Instruments categories, averaging 8% (median) across all firms.

The right hand side of Table 4 illustrates how much value undiversified employees sacrifice by holding company stock relative to the stock's market value, measured by comparing the stock's market value to its value to a completely undiversified employee investors whose portfolios comprise exclusively company stock. The ratio of the latter to the former is labeled "Cost of Employee's Risk Exposure: Stock Value to an Undiversified Investor/Market Value of Stock." We can see that the shorter the holding

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[37] . For comparison purposes, a Fidelity study of plans for which it provides record keeping services (these plans accounted for a total of $388 billion in assets) reports that 62% of plans with more than 2,500 participants offer company stock as an investment option and, of those, an average of 28% of plan assets are invested in company stock. See "Fidelity Investments' Building Futures (Volume III): A Report on Corporate Defined Contribution Plans" (2001).

period, the less value employees forego by holding company stock. An undiversified employee investor with a three-year horizon will sacrifice (on average) 33% of the stock's market value by holding company stock (the 67% displayed in the table is the mean value retained). Extending the holding period to ten years increases this number dramatically: the undiversified employee who holds exclusively company stock sacrifices a mean of 68% (and retains 32%) of the stock's market value (medians are 71% sacrificed and 29% retained). With a fifteen-year holding period, an average (mean) 80% of the stock market value is sacrificed (median of 84%).

Because employees are likely to hold at least some of their wealth outside their pension plans, and because their pension plan holdings are not composed entirely of company stock, Table 5 adjusts the numbers presented in Table 4 to reflect the value sacrificed by partially-diversified investors.[38] These estimates allow employees' pension wealth to range from ten percent to one hundred percent of total wealth; the proportion of defined-contribution pension assets invested in company stock ranges from five percent to one hundred percent of pension assets. Table 5's four panels correspond to four different holding periods, Panel A to a three-year, B to a five-year, C to a ten-year, and D to a fifteen-year holding period.

Suppose that pension holdings constitute 50% of an employee's total wealth and that 25% of those holdings is invested in company stock (i.e., 12.5% of the employee's total wealth is held in company stock). Panel C of Table 5 shows that an employee with a ten-year holding period sacrifices 27% of the stock's market value by not being fully diversified.[39] This figure is smaller for employees of the average NYSE firm (16%) and higher for employees in Internet-based firms (48%). An employee with a larger percentage of pension-plan wealth in company stock, say 50% (meaning that 25% of the

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[38] Poterba, Venti and Wise (1999) estimate that for households that reach retirement age between 2025 and 2035, 401(k) balances are likely to represent from one-half to twice Social Security wealth (depending on investment allocation and based on current Social Security provisions).

[39] Ten years is probably a reasonable guess for holding periods as firms typically require employees to be anywhere from fifty to sixty years old before diversifying their company stock holdings (at least those that come from the company contribution to the pension plan). Fidelity's survey of its customers' participants shows that twenty-nine percent of defined contribution participants are 30-39; thirty-two percent 40-49; and twenty-one percent 50-59 years old ("Fidelity Investments' Building Futures (Volume III): A Report on Corporate Defined Contribution Plans" (2001)).

employee's total wealth is invested in company stock), sacrifices on average 42% of the stock's value by failing to diversify. If the holding period is extended to fifteen years and 25% of total wealth is invested in company stock, 52% of the stock's market value will be sacrificed by failing to diversify. At the extreme, if 100% of an employee's wealth is invested in company stock, 80% of the market value of the stock will be sacrificed with a fifteen-year holding period (68% if the holding period is reduced to ten years). Even when a relatively low percentage of an employee's wealth is invested in company stock, the value sacrificed by forgoing diversification can be substantial.

One implication of this result is that stock purchase plans that allow employees to buy company stock at a discount to market value may not be a good deal for employees if they cannot or do not sell the discounted stock they acquire.[40] To be sure, for an employee who sacrifices half of its market value by holding company stock, a discount of more than fifty percent would be required to make the investment attractive. A related point is that employees might be better off avoiding company stock even if they believe it to be *undervalued* in the market. Indeed, for an employee who sacrifices fifty percent of her company's stock market value by holding it, a stock must be undervalued by more than fifty percent to make such a purchase a good investment.

Is there any evidence that managers or employees recognize the substantial costs of holding company stock? The overall high levels of company stock holdings suggests not, but the aggregate numbers mask the correlation between costs and actual ownership. It could conceivably be the case that the firms' with the highest costs associated with company stock holdings hold the least company stock in their pension plans. To address this question, Table 6 uses Form 5500 pension data to show how the cost of holding company stocks varies with the actual ownership level of that stock in the firm's pension plan. The table divides the sample into quintiles that reflect the percent of each firm's holdings of company stock. The table is further subdivided into panels, where Panel A uses all the firms in our sample, Panel B only firms that have at least some company stock holdings in their pension plans. If managers or employees understand how the cost

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[40] A 15% discount is common.

of holding company stock compares to the cost experienced by other firms, we would expect to see that the plans with the highest concentration of company stock holdings tend would be the ones with the lowest costs. Data in Panel B confirms this negative correlation between ownership and cost. For a ten-year holding period, firms that fall into the highest quintile of company stock ownership (with a median of 74% of pension plan assets invested in company stock) sacrifice 56% of market value after adjusting for the increased risk that accompanies a loss in portfolio diversification. The corresponding number for the smallest quintile of company stock ownership, 71%, represents a higher level of value sacrificed to failure to diversify. These patterns are consistent with the notion that, on average, either firms or plan participants are aware of the costs associated with lost diversification and less likely to hold portfolios that are less-than-fully diversified when costs are largest. Still, on an absolute level, the costs of holding company stock are substantial even for those firms that hold relatively more company stock in their pension plans.

In Table 6, the costs of holding company stock assume that employees are completely undiversified. But, we know that when pension plans hold less than 100% of their assets in company stock, it is unlikely that the participants in that plan are completely undiversified. While we do not know the magnitude of employees' non-pension plan assets, we can take into account the degree of diversification in the plan itself. Table 7 is similar to Table 6, but illustrates the cost of lost diversification to the firm's "typical" pension plan investor, that is, an employee who hold her wealth in company stock in proportion equal to the percentage of firm's pension assets in company stock. For firms that fall into the highest quintile of company stock ownership (with a median of 74% of pension plan assets invested in company stock), employees whose total wealth is invested in company stock in the same proportion as the pension plan (i.e. 74% in company stock) sacrifice 42% of total wealth. So, this rough adjustment for non-pension-based assets leaves the essential finding unchanged: employees holding company stock forego substantial value by doing so.

V. Conclusions

Employees are frequently restricted from selling company stock held in their pension plans, especially such stock holdings as result from firm contribution to employees' pension plans.[41] Even when not restricted from diversifying, many employees choose to invest their retirement savings in company stock, which constitutes more than 80% of defined contribution pension plan assets at companies such as Coca-Cola, Colgate-Palmolive, Pfizer, and Procter & Gamble, to name but a few. Yet employees who hold company stock sacrifice substantial value to do so. Holding company stock costs employees some degree of diversification, which exposes them to risk that fully-diversified investors do not face. Nor are employees compensated for bearing this extra risk with higher expected or realized returns; their returns are the same as those of fully-diversified investors. As a consequence, employees value their company stock holdings at less than market value.

This paper investigates the cost to employees of holding company stock by estimating the value lost when diversification declines. It is important to recognize that the cost of holding company stock, at least as measured in this paper, is a function not of the level of risk associated with holding a single-stock portfolio, but of the lack of compensation received for bearing that risk. More precisely, even employees willing to bear a high level of risk will receive a substantially lower expected return from holding company stock than from holding a diversified (levered) stock portfolio with an equivalent risk level. It is the *type* of risk that is costly, not the *level* of risk per se.[42] Moreover,

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[41] According to Employee Benefit Research Institute (EBRI), 49% of large employers restrict investment based on specified age and/or service requirements.

[42] For relatively risk-averse employees, the costs of holding company stock will exceed those reported in this paper. In practice, *both* level and type of risk can cause employees to value their company stock holdings at less than market value, but in this paper we measure only the cost from the type of risk exposure. Accounting for the additional penalty created by the level of risk exposure is not easily accomplished because one must know an employee's utility function and its appropriate parameters. A second reason for ignoring risk level in our cost calculations is that financial engineering can alter the risk level (at least in theory), but can do nothing to modify the cost of lost diversification. (See, for example, Rohrer (1995), who discusses how employees can hedge the stock volatility derived from their market exposure. Indexed options are another way firms can alter managers' systematic risk exposure; see Meulbroek (2001a), Meulbroek (2001c), Garvey and Milbourn (2001), Gibbons and Murphy (1990), Akhigbe and Madura (1996), Angel and McCabe (1997), Bettis, Bizjak and Lemmon (2001), and Rappaport

employees are probably even more undiversified than their asset portfolios would suggest because their current jobs and expected future incomes depend, at least to some extent, upon their employers' success or failure.[43]

Employees sacrifice considerable value by investing their retirement savings in company stock. If half of an employee's wealth is invested in a firm's pension plan and half of the pension plan's assets are invested in company stock, on average 42% of the stock's market value will be sacrificed by failing to diversify.[44] For risky firms this amount is even higher. The cost to employees is large, but is not borne by them alone; the firm participates, too. This is so because firms grant stock to employees at the expense of issuing it publicly to diversified investors who value it more highly.[45] Thus, the firm's cost of granting company stock is its market value, but its value to employees is much less than that.

The magnitude of the gap between the firm's cost of granting stock to employees and its market value is critical to understanding the effects of proposed legislation to limit company stock ownership in defined contribution pension plans. A concern voiced by some observers is that restricting the level of company stock ownership in pension plans will discourage employers from contributing to employee pension plans, and without these contributions, employees might have less incentive to contribute to their 401(k) plans.[46] The findings in this paper suggest the opposite: unless firms realize benefits such

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(1999)). Consequently, the results reported in this paper are conservative, meaning that the actual cost of holding company stock is likely to be *greater* than the numbers reported here.

[43] For a discussion of retirement risks, both systematic and idiosyncratic, see Bodie, Hammond and Mitchell (2001)

[44] That is, 25% of the employee's wealth consists of company stock. The value calculated is based on an investment horizon of ten years.

[45] This cost is not only an "opportunity cost." Benartzi (2001) cites evidence that roughly 40% of firms that contribute shares to 401(k) plans purchase them on the open market

[46] Much of firms' current contributions come in the form of company stock. Industry organizations such as the National Center for Employee Ownership, the Employee Benefits Research Institute, the American Benefits Council, and the Profit Sharing/401k Council of America have suggested that such contributions might be at risk if company stock limits were adopted. Voicing their argument, Angela Reynolds Director, International Pension & Benefits, NCR Corporation, testifying before the House's Subcommittee on Employer-Employee Relations (February 27, 2002) said: "Percentage would be unpopular with – and contrary to the best interests of -- the many employees who benefit from having an ownership stake in their company. Indeed, recent research has shown that 401(k) investment returns for workers would be lower were company stock removed from these plans. Moreover, Congress simply cannot know how much

as higher levels of motivation from employees' ownership positions, both employees and firms would be better off if stock were issued in the open market and contributions to employee matches made in the form of cash.

If holding company stock is so costly, why do employees do so voluntarily? We know that employees' pension plan holdings appear to be suboptimal along many dimensions. For instance, Benartzi and Thaler (2001) show that participants in defined contribution plans appear to follow a "1/n" diversification strategy; that is, to put an equal amount across the investment options offered in a plan irrespective of the type of investment option. Similarly, Benartzi (2001) reports that employees erroneously extrapolate past performance when making asset allocation decisions and Madrian and Shea (2001) and Choi, Laibson, Madrian and Metrick (2001b) find employees to be passive investors whose savings and asset allocations largely reflect the default options set by their employers; where enrollment in 401(k) plans is automatic few employees opt out and fully 80% of participants initially accept both the default savings rate and default investment fund. Even after three years, half of plan participants subject to automatic enrollment continue to contribute at the default and invest their contributions exclusively in the default fund. Perhaps employees are following the quotidian advice to "invest in what you know." If employees invest according to that strategy and believe that the stock they "know" best must be their employer's, excessive company stock holdings might result. The alternative explanation that employees are privy to inside information seems unlikely for all except top management, and it appears equally unlikely that were employees to possess such information, they could effectively translate that information into accurate estimates of their firms' stock prices.

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investment in employer stock is appropriate for each 401(k) participant. This decision depends upon a myriad of personal variables -- a worker's age and planned retirement date, traditional pension coverage or lack thereof, the existence of." That employer contributions spur employee contributions is well-documented: Munnell, Sunden and Taylor (2000), Papke and Poterba (1995), Papke (1995), Clark and Schieber (1998), and Kusko, Poterba and Wilcox (1998) all find evidence that employer matching contributions increase employee participation in 401(k) plans. What is less certain, however, is that broad-based employee ownership translates into greater shareholder value. And, if employers gain no benefit of substance from employee stock ownership, the switch to cash-based matching funds could well lead to *increased*, not decreased, contributions because (as the results in this paper show) cash payments would be pareto optimal for both employee and employer.

Finally, anecdotal evidence suggests that some employees misunderstand the risk of owning company stock and are "swinging for the fences," hoping for their firms' stocks to skyrocket. Because the expected returns from company stock will not adequately compensate employees for bearing the added risk that attends their lack of diversification, holding company stock takes on more the flavor of buying a lottery ticket than an investment strategy, and an expensive lottery ticket at that. Employees willing to bear the higher risk levels associated with a single-stock portfolio would earn a much higher expected return were they to hold a diversified equity portfolio levered up to the single stock's volatility level. Just as a lottery ticket is not an actuarially fair bet (i.e. its cost exceeds its expected payout) and hardly a sound financial practice, owning a single stock is also not an "actuarially fair bet" because it engenders an "inefficient" risk exposure: employees are exposed to risk for which they are not "compensated" with higher expected returns. One suspects that few people would be willing to send their entire savings on lottery tickets, but this is precisely what employees who own company stock do.

That substantial value is sacrificed by holding company stock as reported in this paper has a number of practical implications. First, firms need to carefully weigh the benefits they hope to achieve through broader employee stock ownership against the costs of paying employees in a currency that costs more than it is worth to them. Second, employees who hold company stock should not use market values to estimate the value of their retirement savings. Our findings suggest that company stock might be worth only half its market value. Employees who hold company stock should be aware of its risk-adjusted value they make future savings and consumption decisions. Even if company stock sold to employees is discounted, the discount might not compensate for the added risk incurred by not being free to sell the purchased shares. Using the foregoing example, the company stock must be discounted by almost half to justify its acquisition by employees. Even then, firms need to consider whether the cost of selling stock at a discount is worth the value realized by doing so. Finally, government subsidization of retirement plans through tax deferral raises the issue of whether firms or employees should be able to use that subsidy for what appears to be a rather inefficient way to save.

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Table 1

Risk Exposure of a One-Stock Portfolio versus a Well-Diversified Stock Portfolio

Continuously-compounded daily excess returns (net of daily riskless rates) are used in all calculations. The market return is the continuously-compounded value-weighted daily NYSE/AMEX/NASDAQ Composite returns (net of daily riskless rates). Volatility is estimated using 150 trading days of daily returns and annualizing the resulting daily volatility. Firms with fewer than 100 trading days of returns during the 150 day trading estimation window preceding 12/31/98 are not included. Firm daily returns are screened to allow only "Ordinary Common Shares", eliminating ADRs, SBIs, and REITs from the sample. Internet-based firms are firms in Hambrecht & Quist's Internet Index as of 12/31/98.

	Volatility of Single-Stock Portfolio (%)	Volatility of Well-Diversified Stock Portfolio (%)	Ratio of Single-Stock Risk to Well-Diversified Stock Portfolio	Proportion of Risk that could be Eliminated through Diversification (%)
NYSE				
mean	45%	23%	2.0x	86%
median	42%			89%
std dev mean	0%			0%
n	2,787			2,550
AMEX				
mean	55%	23%	2.4x	92%
median	50%			95%
std dev mean	13%			0%
n	519			583
NASDAQ				
mean	81%	23%	3.5x	93%
median	76%			95%
std dev mean	1%			0%
n	3,544			3,540
INTERNET-BASED				
mean	117%	23%	5.1x	83%
median	116%			85%
std dev mean	5%			1%
n	58			53
ALL FIRMS				
mean	65%	23%	2.8x	90%
median	58%			93%
std dev mean	0%			0%
n	6,850			6,673

Table 2
Defined-Contribution Plans in Sample

Pension data from IRS Form 5500 for 1998 plan year (includes all forms filed prior to 9/01) matched to publicly-traded firms listed in CRSP. Employee Identification numbers (from Compustat) and CUSIPs used to match pension data to CRSP permanent company numbers.

	Total Number of Firms listed on CRSP Tape	Total Number of Firms Matched to Plans	Total Number of Plans	Number of Plans per Firm	Total Plan Assets per Firm ($MM)	Total Plan Assets By Firm Type($MM)
NYSE	2,787	1,348	2,451			636,953
mean				1.82	465	
median				1.00	81	
std dev mean				0.04	40	
AMEX	519	247	355			8,325
mean				1.44	34	
median				1.00	6	
std dev mean				0.08	11	
NASDAQ	3,544	2,128	2,852			80,724
mean				1.34	38	
median				1.00	8	
std dev mean				0.02	5	
ALL FIRMS	6,850	3,723	5,657			726,002
mean				1.52	194	
median				1.00	14	
std dev mean				0.02	15	

Table 3
Plan Assets Invested in Company Stock

Pension data from IRS Form 5500 for the 1998 plan year (includes all forms for that year filed prior to 9/01) matched to publicly-traded (CRSP) firms. Firm size is equity value of firm as of 12/31/98.

	Firm Size ($MM)	DC Plan Assets per Firm ($MM)	Percent of Firms with Company Stock > $0	Percent of Pension Plan Assets in Company Stock		Company Stock As a Percentage of Firm Equity Value	
				All Firms	For Firms with Company Stock > $0	All Firms	For Firms with Company Stock > $0
NYSE			52%				
mean	5,676	465		15%	27%	2%	4%
median	926	81		2%	20%	0%	2%
std dev mean	463	40		1%	1%	0%	0%
n	1,348	1,348		1,348	712	1,348	663
AMEX			30%				
mean	132	34		5%	16%	2%	5%
median	38	6		0%	9%	0%	2%
std dev mean	20	11		1%	2%	0%	1%
n	247	247		247	77	247	70
NASDAQ			25%				
mean	979	38		7%	27%	1%	5%
median	104	8		0%	16%	0%	2%
std dev mean	218	5		0%	1%	0%	1%
n	2,128	2,128		2,128	539	2,128	497
ALL FIRMS			31%				
mean	2,623	194		10%	27%	1%	4%
median	216	14		0%	17%	0%	2%
std dev mean	212	15		0%	1%	0%	0%
n	3,723	3,723		3,723	1,328	3,723	1,230

Table 4

Cost of Holding Company Stock instead of Diversified Stock Portfolio

The dataset consists of 1,496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six-month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. *Market Value of Stock* is the stock price as of 12/31/98. *Stock Value Undiversified Investor* is the private value that an employee who holds only company stock requires to compensate for risk of the undiversified portfolio. *Stock Held "X" Years* is the period during which the employee holds the undiversified portfolio of company stock. S_j is the return premium on a stock required by a completely undiversified investor to compensate for bearing the firm's total risk (systematic plus idiosyncratic). Industries are sorted in descending order by S_j.

Industry	# of Firms	Stock Volatility (%)			Extra Return Needed to Compensate for Risk (S_j)			Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock — Stock Held 3 Years			Stock Held 5 Years			Stock Held 10 Years			Stock Held 15 Years		
		MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
Oilfield Services & Equipment	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Textile	11	59%	58%	3%	13%	12%	1%	67%	69%	2%	52%	54%	3%	28%	29%	3%	15%	16%	2%
Precision Instrument	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maritime	4	64%	50%	16%	16%	11%	5%	64%	71%	8%	49%	57%	9%	26%	32%	7%	15%	18%	5%
Trucking & Transportation Leasing	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Retail (Special Lines)	55	64%	61%	3%	12%	11%	1%	71%	72%	1%	57%	57%	2%	34%	33%	2%	20%	19%	1%
Computer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Steel	16	49%	49%	5%	10%	10%	1%	74%	73%	2%	61%	59%	3%	38%	35%	4%	25%	21%	4%
Electronics & Semiconductor	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Medical Services	22	60%	54%	4%	12%	10%	1%	72%	73%	2%	58%	59%	3%	36%	35%	3%	23%	21%	3%
Telecommunications	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Apparel & Shoe	22	54%	53%	3%	11%	10%	1%	72%	74%	2%	59%	60%	2%	35%	36%	2%	22%	22%	2%
Office Equip. & Supplies	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Restaurant	26	50%	50%	3%	10%	10%	1%	74%	75%	2%	61%	61%	2%	39%	38%	2%	25%	23%	2%
Broadcasting & Cable TV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Medical Supplies	49	52%	47%	2%	10%	10%	1%	75%	75%	1%	62%	62%	2%	39%	38%	2%	26%	24%	2%
Industrial Services (inc. Environmental)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Drug	39	56%	53%	3%	10%	9%	1%	75%	75%	2%	63%	62%	2%	42%	39%	3%	29%	24%	3%
Machinery	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hotel & Gaming	12	49%	48%	3%	9%	9%	1%	76%	76%	2%	63%	63%	2%	40%	40%	3%	26%	25%	3%
Metals and Mining	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Auto & Truck	8	50%	47%	3%	8%	9%	1%	79%	77%	2%	68%	64%	3%	47%	41%	4%	32%	27%	4%
Auto Parts	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Recreation	31	60%	55%	4%	10%	9%	1%	74%	77%	2%	62%	65%	3%	40%	42%	3%	27%	27%	3%
Manufactured Housing & RV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Metal Fabricating	13	45%	44%	3%	9%	8%	1%	76%	78%	2%	64%	66%	3%	42%	43%	3%	28%	28%	3%
Packaging & Container	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 4 (cont.)

Cost of Holding Company Stock instead of Diversified Stock Portfolio

The dataset consists of 1,496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six-month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. *Market Value of Stock* is the stock price as of 12/31/98. *Stock Value Undiversified Investor* is the private value that an employee who holds only company stock requires to compensate for risk of the undiversified portfolio. *Stock Held "X" Years* is the period during which the employee holds the undiversified portfolio of company stock. S_j is the return premium on a stock required by a completely undiversified investor to compensate for bearing the firm's total risk (systematic plus idiosyncratic). Industries are sorted in descending order by S_j.

Industry	# of Firms	Stock Volatility (%)			Extra Return Needed to Compensate for Risk (S_j)			Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock — Stock Held 3 Years			Stock Held 5 Years			Stock Held 10 Years			Stock Held 15 Years		
		MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
Food Processing	44	42%	40%	2%	9%	8%	0%	77%	78%	1%	66%	66%	2%	44%	44%	2%	30%	29%	2%
[redacted]																			
Chemical	64	44%	40%	2%	9%	8%	0%	77%	79%	1%	65%	67%	1%	43%	45%	2%	30%	30%	2%
[redacted]																			
Aerospace & Defense	15	42%	40%	3%	8%	8%	1%	78%	80%	1%	67%	68%	2%	45%	47%	3%	31%	32%	2%
[redacted]																			
Food Wholesalers & Grocery Stores	18	39%	37%	3%	8%	8%	1%	79%	80%	2%	68%	69%	2%	47%	47%	3%	33%	32%	3%
[redacted]																			
Paper & Forest Products	26	40%	37%	2%	7%	7%	0%	81%	81%	1%	70%	70%	2%	50%	49%	2%	36%	34%	2%
[redacted]																			
Petroleum	38	42%	39%	2%	8%	7%	0%	79%	81%	1%	68%	70%	2%	47%	49%	2%	33%	35%	2%
[redacted]																			
Tobacco	6	34%	32%	2%	7%	7%	1%	82%	81%	1%	71%	71%	2%	51%	50%	3%	37%	35%	3%
[redacted]																			
Railroad	6	43%	33%	7%	7%	6%	1%	81%	82%	2%	70%	72%	3%	50%	52%	4%	36%	38%	4%
[redacted]																			
Natural Gas	41	34%	30%	2%	7%	6%	0%	82%	84%	1%	72%	74%	1%	52%	55%	2%	39%	41%	2%
[redacted]																			
Electrical Equipment & Home Appliance	22	38%	37%	3%	7%	6%	1%	81%	84%	2%	71%	75%	2%	52%	56%	3%	39%	42%	3%
[redacted]																			
Insurance	36	41%	39%	3%	7%	5%	1%	82%	85%	2%	73%	76%	2%	54%	58%	2%	41%	45%	2%
[redacted]																			
Drugstore	5	48%	45%	6%	8%	5%	3%	80%	86%	5%	69%	78%	7%	50%	61%	9%	38%	48%	9%
[redacted]																			

Table 4 (cont.)
Cost of Holding Company Stock instead of Diversified Stock Portfolio

The dataset consists of 1,496 firms tracked by Value Line and 53 firms in Hambrecht & Quist Internet-Based Index as of 12/31/98. The calculations use daily continuously-compounded excess return (net of risk-free rate) over the six-month period ending 12/31/98. If six months of data is not available, we use the available data, as long as that data covers at least three months. CRSP's Value-Weighted Composite Index is used for the market return. Market Value of Stock is the stock price as of 12/31/98. Stock Value Undiversified Investor is the private value that an employee who holds only company stock requires to compensate for risk of the undiversified portfolio. Stock Held "X" Years is the period during which the employee holds the undiversified portfolio of company stock. Sj is the return premium on a stock required by a completely undiversified investor to compensate for bearing the firm's total risk (systematic plus idiosyncratic). Industries are sorted in descending order by Sj.

Summary Statistics Across Industries and Across Firms

		# of Firms	Stock Volatility (%)	Extra Return Needed to Compensate for Risk (S_j)	Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock			
					Stock Held 3 Years	Stock Held 5 Years	Stock Held 10 Years	Stock Held 15 Years
Industry Summary Stats (Industries are equally-weighted)	mean	27.4	49%	9%	77%	65%	43%	30%
	median	22	49%	9%	77%	66%	44%	30%
	std dev mean	2.7	1%	1%	1%	1%	1%	1%

		# of Firms	Stock Volatility (%)	Extra Return Needed to Compensate for Risk (S_j)	Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock			
					Stock Held 3 Years	Stock Held 5 Years	Stock Held 10 Years	Stock Held 15 Years
Firm Summary Data (Firms are equally-weighted)	mean	-	65%	9%	67%	53%	32%	20%
	median	-	58%	8%	69%	54%	29%	16%
	std dev mean	-	0%	0%	0%	0%	0%	0%

Table 5

The Effect of Employee's Savings Outside the Pension Plan on the Cost of Holding Company Stock Measured by Employee's Private Value Relative to the Market Value of Stock

Pension data from 1998 IRS Form 5500. The numbers in the table represent the employee's private value of company stock (i.e. value of the stock to partially-diversified investor) relative to the stock's market value. The employee's private value is the price required to compensate an employee who holds only company stock for the firm's total risk (firm-specific plus market risk) an undiversified investor must bear, estimate as the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock uses the 12/31/98 stock price.

Panel A: Employee Holds Company Stock for 3 Years

% Wealth in Pension	Percent of Pension Assets Invested in Company Stock																	
100% in Pension	5% of Pension			10% of Pension			25% of Pension			50% of Pension			75% of Pension			100% of Pension		
	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
100%																		
NYSE	0.98	0.99	0.00	0.96	0.97	0.00	0.90	0.93	0.00	0.84	0.87	0.00	0.80	0.82	0.00	0.77	0.79	0.00
AMEX	0.96	0.97	0.00	0.92	0.94	0.00	0.83	0.86	0.00	0.75	0.77	0.00	0.70	0.72	0.00	0.66	0.68	0.00
NASD	0.93	0.95	0.00	0.88	0.90	0.00	0.76	0.79	0.00	0.66	0.68	0.00	0.61	0.63	0.00	0.58	0.60	0.00
Internet Based	0.91	0.91	0.01	0.84	0.86	0.01	0.71	0.72	0.02	0.63	0.63	0.02	0.59	0.58	0.02	0.57	0.56	0.02
ALL FIRMS	0.95	0.97	0.00	0.91	0.94	0.00	0.83	0.86	0.00	0.75	0.78	0.00	0.70	0.72	0.00	0.67	0.69	0.00
75%																		
NYSE	0.98	0.99	0.00	0.97	0.98	0.00	0.92	0.94	0.00	0.87	0.89	0.00	0.83	0.85	0.00	0.80	0.82	0.00
AMEX	0.97	0.98	0.00	0.94	0.96	0.00	0.86	0.89	0.00	0.78	0.81	0.00	0.73	0.75	0.00	0.70	0.72	0.00
NASD	0.95	0.96	0.00	0.90	0.92	0.00	0.80	0.83	0.00	0.70	0.72	0.00	0.65	0.66	0.00	0.61	0.63	0.00
Internet Based	0.93	0.93	0.01	0.87	0.89	0.01	0.75	0.76	0.02	0.65	0.66	0.02	0.62	0.61	0.02	0.59	0.58	0.02
ALL FIRMS	0.96	0.98	0.00	0.93	0.96	0.00	0.86	0.89	0.00	0.78	0.81	0.00	0.73	0.76	0.00	0.70	0.72	0.00
50%																		
NYSE	0.99	0.99	0.00	0.98	0.99	0.00	0.95	0.96	0.00	0.90	0.93	0.00	0.87	0.89	0.00	0.84	0.87	0.00
AMEX	0.98	0.99	0.00	0.96	0.97	0.00	0.90	0.93	0.00	0.83	0.86	0.00	0.79	0.81	0.00	0.75	0.77	0.00
NASD	0.96	0.97	0.00	0.93	0.95	0.00	0.85	0.88	0.00	0.76	0.79	0.00	0.70	0.72	0.00	0.66	0.68	0.00
Internet Based	0.95	0.95	0.00	0.91	0.93	0.01	0.81	0.83	0.01	0.72	0.74	0.02	0.66	0.68	0.02	0.63	0.63	0.02
ALL FIRMS	0.98	0.98	0.00	0.95	0.97	0.00	0.90	0.93	0.00	0.83	0.86	0.00	0.78	0.81	0.00	0.75	0.78	0.00
25%																		
NYSE	0.99	1.00	0.00	0.99	0.99	0.00	0.97	0.98	0.00	0.95	0.96	0.00	0.92	0.94	0.00	0.90	0.93	0.00
AMEX	0.99	0.99	0.00	0.98	0.99	0.00	0.95	0.96	0.00	0.89	0.92	0.00	0.86	0.89	0.00	0.83	0.86	0.00
NASD	0.98	0.99	0.00	0.96	0.97	0.00	0.92	0.94	0.00	0.85	0.88	0.00	0.80	0.83	0.00	0.76	0.79	0.00
Internet Based	0.97	0.98	0.00	0.95	0.96	0.00	0.89	0.91	0.01	0.81	0.84	0.01	0.75	0.78	0.02	0.72	0.74	0.02
ALL FIRMS	0.99	0.99	0.00	0.98	0.98	0.00	0.94	0.96	0.00	0.90	0.93	0.00	0.86	0.89	0.00	0.83	0.86	0.00
10%																		
NYSE	1.00	1.00	0.00	1.00	1.00	0.00	0.99	0.99	0.00	0.98	0.99	0.00	0.97	0.98	0.00	0.96	0.97	0.00
AMEX	1.00	1.00	0.00	0.99	0.99	0.00	0.98	0.99	0.00	0.96	0.97	0.00	0.94	0.95	0.00	0.92	0.94	0.00
NASD	0.99	0.99	0.00	0.98	0.99	0.00	0.96	0.97	0.00	0.93	0.95	0.00	0.90	0.92	0.00	0.88	0.90	0.00
Internet Based	0.99	0.99	0.00	0.98	0.98	0.00	0.95	0.95	0.00	0.90	0.91	0.01	0.87	0.89	0.01	0.84	0.85	0.01
ALL FIRMS	0.99	1.00	0.00	0.99	0.99	0.00	0.98	0.98	0.00	0.95	0.97	0.00	0.93	0.96	0.00	0.91	0.94	0.00

Table 5 (cont.)

The Effect of Employee's Savings Outside the Pension Plan on the Cost of Holding Company Stock Measured by Employee's Private Value Relative to the Market Value of Stock

Pension data from 1998 IRS Form 5500. The numbers in the table represent the employee's private value of company stock (i.e. value of the stock to partially-diversified investor) relative to the stock's market value. The employee's private value is the price required to compensate an employee who holds only company stock for the firm's total risk (firm-specific plus market risk) an undiversified investor must bear, estimate as the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock uses the 12/31/98 stock price.

Panel B: Employee Holds Company Stock for 5 Years

% Wealth In Pension	Percent of Pension Assets Invested in Company Stock																	
100% In Pension	5% of Pension			10% of Pension			25% of Pension			50% of Pension			75% of Pension			100% of Pension		
	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
100%																		
NYSE	0.96	0.98	0.00	0.93	0.95	0.00	0.85	0.88	0.00	0.76	0.79	0.00	0.70	0.72	0.00	0.65	0.68	0.00
AMEX	0.93	0.95	0.00	0.87	0.91	0.00	0.75	0.78	0.01	0.63	0.66	0.01	0.56	0.57	0.01	0.52	0.52	0.01
NASD	0.89	0.91	0.00	0.81	0.84	0.00	0.65	0.67	0.00	0.52	0.53	0.00	0.46	0.46	0.00	0.42	0.42	0.00
Internet Based	0.85	0.86	0.01	0.75	0.75	0.01	0.58	0.57	0.02	0.45	0.46	0.03	0.38	0.41	0.03	0.34	0.38	0.03
ALL FIRMS	0.93	0.95	0.00	0.87	0.90	0.00	0.74	0.78	0.00	0.63	0.66	0.00	0.57	0.58	0.00	0.53	0.54	0.00
75%																		
NYSE	0.97	0.98	0.00	0.95	0.96	0.00	0.88	0.91	0.00	0.80	0.83	0.00	0.74	0.77	0.00	0.70	0.72	0.00
AMEX	0.95	0.96	0.00	0.90	0.93	0.00	0.79	0.83	0.01	0.68	0.71	0.01	0.61	0.62	0.01	0.56	0.57	0.01
NASD	0.92	0.94	0.00	0.85	0.88	0.00	0.70	0.73	0.00	0.57	0.58	0.00	0.50	0.51	0.00	0.46	0.46	0.00
Internet Based	0.88	0.90	0.01	0.79	0.80	0.01	0.63	0.66	0.02	0.50	0.50	0.03	0.42	0.42	0.03	0.38	0.40	0.03
ALL FIRMS	0.94	0.96	0.00	0.89	0.93	0.00	0.79	0.83	0.00	0.68	0.71	0.00	0.61	0.63	0.00	0.57	0.58	0.00
50%																		
NYSE	0.98	0.99	0.00	0.96	0.98	0.00	0.92	0.94	0.00	0.85	0.88	0.00	0.80	0.83	0.00	0.76	0.79	0.00
AMEX	0.96	0.98	0.00	0.93	0.95	0.00	0.85	0.88	0.01	0.75	0.78	0.01	0.68	0.70	0.01	0.63	0.64	0.01
NASD	0.94	0.96	0.00	0.89	0.91	0.00	0.77	0.81	0.00	0.65	0.67	0.00	0.57	0.58	0.00	0.52	0.53	0.00
Internet Based	0.92	0.92	0.01	0.85	0.86	0.01	0.71	0.72	0.02	0.58	0.57	0.02	0.52	0.50	0.03	0.47	0.48	0.03
ALL FIRMS	0.96	0.98	0.00	0.93	0.95	0.00	0.84	0.88	0.00	0.74	0.78	0.00	0.68	0.71	0.00	0.63	0.66	0.00
25%																		
NYSE	0.99	0.99	0.00	0.98	0.99	0.00	0.95	0.97	0.00	0.92	0.94	0.00	0.88	0.91	0.00	0.85	0.88	0.00
AMEX	0.98	0.99	0.00	0.96	0.98	0.00	0.91	0.93	0.00	0.85	0.88	0.01	0.80	0.82	0.01	0.75	0.78	0.01
NASD	0.97	0.98	0.00	0.94	0.96	0.00	0.87	0.90	0.00	0.77	0.81	0.00	0.70	0.73	0.00	0.65	0.67	0.00
Internet Based	0.96	0.96	0.00	0.92	0.92	0.00	0.82	0.83	0.01	0.71	0.72	0.02	0.63	0.63	0.02	0.58	0.57	0.02
ALL FIRMS	0.98	0.99	0.00	0.96	0.98	0.00	0.91	0.94	0.00	0.84	0.88	0.00	0.79	0.83	0.00	0.74	0.78	0.00
10%																		
NYSE	1.00	1.00	0.00	0.99	1.00	0.00	0.98	0.99	0.00	0.96	0.98	0.00	0.95	0.96	0.00	0.93	0.95	0.00
AMEX	0.99	1.00	0.00	0.98	0.99	0.00	0.96	0.98	0.00	0.93	0.95	0.00	0.90	0.93	0.00	0.87	0.90	0.00
NASD	0.99	0.99	0.00	0.98	0.98	0.00	0.94	0.96	0.00	0.89	0.91	0.00	0.85	0.88	0.00	0.81	0.84	0.00
Internet Based	0.98	0.98	0.00	0.97	0.97	0.00	0.92	0.92	0.01	0.85	0.86	0.01	0.79	0.80	0.02	0.74	0.75	0.02
ALL FIRMS	0.99	0.99	0.00	0.98	0.99	0.00	0.96	0.98	0.00	0.93	0.95	0.00	0.89	0.93	0.00	0.87	0.90	0.00

Table 5 (cont.)

The Effect of Employee's Savings Outside the Pension Plan on the Cost of Holding Company Stock Measured by Employee's Private Value Relative to the Market Value of Stock

Pension data from 1998 IRS Form 5500. The numbers in the table represent the employee's private value of company stock (i.e. value of the stock to partially-diversified investor) relative to the stock's market value. The employee's private value is the price required to compensate an employee who holds only company stock for the firm's total risk (firm-specific plus market risk) an undiversified investor must bear, estimate as the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock uses the 12/31/98 stock price.

Panel C: Employee Holds Company Stock for 10 Years

% Wealth in Pension	Percent of Pension Assets Invested in Company Stock																	
100% in Pension	5% of Pension			10% of Pension			25% of Pension			50% of Pension			75% of Pension			100% of Pension		
	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
100%																		
NYSE	0.93	0.95	0.00	0.87	0.90	0.00	0.74	0.78	0.00	0.60	0.62	0.00	0.51	0.52	0.00	0.45	0.46	0.00
AMEX	0.87	0.91	0.01	0.78	0.82	0.01	0.59	0.62	0.01	0.47	0.47	0.01	0.40	0.38	0.01	0.36	0.27	0.01
NASD	0.80	0.84	0.00	0.67	0.70	0.00	0.45	0.45	0.00	0.30	0.28	0.00	0.24	0.21	0.00	0.20	0.18	0.00
Internet-Based	0.74	0.74	0.02	0.57	0.56	0.03	0.37	0.36	0.03	0.26	0.24	0.03	0.22	0.17	0.03	0.19	0.14	0.02
ALL FIRMS	0.86	0.90	0.00	0.76	0.82	0.00	0.58	0.61	0.00	0.44	0.43	0.00	0.36	0.34	0.00	0.32	0.29	0.00
75%																		
NYSE	0.95	0.96	0.00	0.90	0.93	0.00	0.79	0.83	0.00	0.66	0.69	0.00	0.57	0.59	0.00	0.51	0.52	0.00
AMEX	0.90	0.93	0.00	0.82	0.86	0.01	0.65	0.69	0.01	0.50	0.49	0.01	0.41	0.39	0.01	0.36	0.28	0.01
NASD	0.85	0.88	0.00	0.73	0.77	0.00	0.52	0.53	0.00	0.36	0.34	0.00	0.28	0.26	0.00	0.24	0.21	0.00
Internet-Based	0.78	0.79	0.03	0.65	0.68	0.03	0.46	0.46	0.03	0.30	0.25	0.03	0.22	0.20	0.03	0.22	0.16	0.03
ALL FIRMS	0.89	0.93	0.00	0.81	0.86	0.00	0.64	0.69	0.00	0.50	0.51	0.00	0.42	0.40	0.00	0.36	0.34	0.00
50%																		
NYSE	0.96	0.98	0.00	0.93	0.95	0.00	0.84	0.88	0.00	0.74	0.78	0.00	0.66	0.69	0.00	0.60	0.62	0.00
AMEX	0.93	0.95	0.00	0.87	0.90	0.01	0.74	0.78	0.01	0.59	0.61	0.01	0.50	0.49	0.01	0.44	0.35	0.01
NASD	0.89	0.91	0.00	0.80	0.84	0.00	0.62	0.65	0.00	0.45	0.45	0.00	0.36	0.34	0.00	0.30	0.28	0.00
Internet-Based	0.85	0.85	0.01	0.71	0.74	0.02	0.52	0.50	0.01	0.37	0.33	0.01	0.30	0.25	0.01	0.26	0.21	0.01
ALL FIRMS	0.92	0.95	0.00	0.86	0.90	0.00	0.73	0.78	0.00	0.58	0.61	0.00	0.50	0.51	0.00	0.44	0.43	0.00
25%																		
NYSE	0.98	0.99	0.00	0.96	0.98	0.00	0.91	0.94	0.00	0.84	0.88	0.00	0.79	0.83	0.00	0.74	0.78	0.00
AMEX	0.96	0.98	0.00	0.93	0.95	0.00	0.84	0.88	0.01	0.74	0.78	0.01	0.65	0.69	0.01	0.59	0.61	0.01
NASD	0.94	0.96	0.00	0.89	0.91	0.00	0.77	0.80	0.00	0.62	0.65	0.00	0.52	0.53	0.00	0.45	0.45	0.00
Internet-Based	0.92	0.92	0.01	0.85	0.85	0.01	0.68	0.68	0.02	0.52	0.50	0.02	0.43	0.40	0.02	0.37	0.35	0.03
ALL FIRMS	0.96	0.98	0.00	0.92	0.95	0.00	0.84	0.88	0.00	0.73	0.78	0.00	0.64	0.69	0.00	0.58	0.61	0.00
10%																		
NYSE	0.99	1.00	0.00	0.98	0.99	0.00	0.96	0.98	0.00	0.93	0.95	0.00	0.90	0.93	0.00	0.87	0.90	0.00
AMEX	0.99	0.99	0.00	0.97	0.98	0.00	0.93	0.95	0.00	0.86	0.87	0.01	0.82	0.86	0.01	0.78	0.82	0.01
NASD	0.98	0.98	0.00	0.95	0.97	0.00	0.89	0.91	0.00	0.80	0.84	0.00	0.73	0.77	0.00	0.67	0.70	0.00
Internet-Based	0.97	0.97	0.00	0.95	0.94	0.01	0.85	0.88	0.01	0.78	0.74	0.02	0.64	0.62	0.02	0.57	0.56	0.03
ALL FIRMS	0.98	0.99	0.00	0.97	0.98	0.00	0.92	0.95	0.00	0.86	0.90	0.00	0.81	0.86	0.00	0.76	0.82	0.00

Table 5 (cont.)

The Effect of Employee's Savings Outside the Pension Plan on the Cost of Holding Company Stock Measured by Employee's Private Value Relative to the Market Value of Stock

Pension data from 1998 IRS Form 5500. The numbers in the table represent the employee's private value of company stock (i.e. value of the stock to partially-diversified investor) relative to the stock's market value. The employee's private value is the price required to compensate an employee who holds only company stock for the firm's total risk (firm-specific plus market risk) an undiversified investor must bear, estimate as the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock uses the 12/31/98 stock price.

Panel D: Employee Holds Company Stock for 15 Years

% Wealth in Pension	Percent of Pension Assets Invested in Company Stock																	
100% in Pension	5% of Pension			10% of Pension			25% of Pension			50% of Pension			75% of Pension			100% of Pension		
	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
100%																		
NYSE	0.90	0.93	0.00	0.82	0.86	0.00	0.65	0.68	0.00	0.48	0.49	0.00	0.38	0.37	0.00	0.32	0.31	0.00
AMEX	0.82	0.86	0.00	0.70	0.74	0.00	0.49	0.47	0.00	0.33	0.27	0.00	0.24	0.19	0.00	0.19	0.15	0.00
NASD	0.73	0.77	0.00	0.57	0.59	0.00	0.33	0.30	0.00	0.19	0.15	0.00	0.13	0.10	0.00	0.11	0.08	0.00
Internet Based	0.63	0.63	0.00	0.45	0.42	0.00	0.25	0.18	0.00	0.15	0.10	0.00	0.12	0.07	0.00	0.11	0.06	0.00
ALL FIRMS	0.81	0.86	0.00	0.69	0.74	0.00	0.48	0.48	0.00	0.33	0.28	0.00	0.25	0.20	0.00	0.20	0.16	0.00
75%																		
NYSE	0.92	0.95	0.00	0.86	0.89	0.00	0.71	0.75	0.00	0.55	0.57	0.00	0.45	0.46	0.00	0.38	0.37	0.00
AMEX	0.86	0.90	0.00	0.75	0.80	0.00	0.56	0.57	0.00	0.39	0.36	0.00	0.30	0.24	0.00	0.24	0.19	0.00
NASD	0.78	0.82	0.00	0.64	0.67	0.00	0.40	0.39	0.00	0.24	0.20	0.00	0.17	0.13	0.00	0.13	0.10	0.00
Internet Based	0.70	0.71	0.00	0.52	0.51	0.00	0.30	0.25	0.00	0.19	0.13	0.00	0.14	0.09	0.00	0.12	0.07	0.00
ALL FIRMS	0.85	0.89	0.00	0.74	0.80	0.00	0.55	0.57	0.00	0.39	0.36	0.00	0.30	0.25	0.00	0.25	0.20	0.00
50%																		
NYSE	0.95	0.96	0.00	0.90	0.93	0.00	0.78	0.83	0.00	0.65	0.68	0.00	0.55	0.57	0.00	0.48	0.49	0.00
AMEX	0.90	0.93	0.00	0.82	0.86	0.00	0.65	0.68	0.00	0.49	0.47	0.00	0.39	0.34	0.00	0.30	0.27	0.00
NASD	0.84	0.88	0.00	0.73	0.77	0.00	0.51	0.52	0.00	0.33	0.30	0.00	0.24	0.20	0.00	0.19	0.15	0.00
Internet Based	0.76	0.79	0.00	0.65	0.68	0.00	0.40	0.35	0.00	0.25	0.19	0.00	0.18	0.13	0.00	0.15	0.10	0.00
ALL FIRMS	0.89	0.93	0.00	0.81	0.86	0.00	0.64	0.68	0.00	0.48	0.48	0.00	0.39	0.36	0.00	0.33	0.28	0.00
25%																		
NYSE	0.97	0.98	0.00	0.95	0.96	0.00	0.88	0.91	0.00	0.78	0.83	0.00	0.71	0.75	0.00	0.65	0.68	0.00
AMEX	0.95	0.96	0.00	0.90	0.93	0.00	0.78	0.83	0.00	0.65	0.68	0.00	0.56	0.57	0.00	0.49	0.49	0.00
NASD	0.92	0.94	0.00	0.84	0.88	0.00	0.68	0.72	0.00	0.51	0.52	0.00	0.40	0.39	0.00	0.33	0.30	0.00
Internet Based	0.88	0.89	0.00	0.78	0.79	0.00	0.56	0.56	0.00	0.39	0.35	0.00	0.30	0.25	0.00	0.25	0.20	0.00
ALL FIRMS	0.94	0.96	0.00	0.89	0.93	0.00	0.77	0.83	0.00	0.64	0.68	0.00	0.55	0.57	0.00	0.48	0.48	0.00
10%																		
NYSE	0.99	0.99	0.00	0.98	0.99	0.00	0.95	0.96	0.00	0.90	0.93	0.00	0.86	0.89	0.00	0.82	0.86	0.00
AMEX	0.98	0.99	0.00	0.96	0.97	0.00	0.93	0.95	0.00	0.82	0.86	0.00	0.75	0.80	0.00	0.70	0.74	0.00
NASD	0.96	0.97	0.00	0.93	0.95	0.00	0.84	0.88	0.00	0.73	0.77	0.00	0.64	0.67	0.00	0.57	0.59	0.00
Internet Based	0.95	0.95	0.00	0.90	0.91	0.00	0.78	0.79	0.00	0.60	0.63	0.00	0.53	0.51	0.00	0.45	0.44	0.00
ALL FIRMS	0.98	0.99	0.00	0.95	0.97	0.00	0.89	0.93	0.00	0.81	0.86	0.00	0.74	0.80	0.00	0.69	0.74	0.00

Table 6

The Cost of Holding Exclusively Company Stock Instead of a Diversified Stock Portfolio Sorted by the Proportion of Pension Assets Invested in Company Stock

Pension data from 1998 IRS Form 5500. Employees Private Value is the private value that an employee who holds only company stock requires to compensate for the total risk (firm-specific plus market risk) an undiversified investor must bear. The private value estimates the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock is the 12/31/98 price.

PANEL A: All Firms with Matching Pension Data

Quintile of % Company Stock to Plan Assets	# of Firms	Proportion of Pension Assets in Company Stock			Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock											
					Stock Held 3 Years			Stock Held 5 Years			Stock Held 10 Years			Stock Held 15 Years		
		MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
Lowest % Company Stock	662	0.00	0.00	0.00	0.70	0.73	0.01	0.56	0.59	0.01	0.35	0.34	0.01	0.23	0.20	0.01
Q2	662	0.00	0.00	0.00	0.62	0.64	0.01	0.47	0.47	0.01	0.27	0.26	0.01	0.17	0.15	0.00
Q3	662	0.00	0.00	0.00	0.57	0.58	0.01	0.41	0.40	0.01	0.19	0.16	0.01	0.10	0.06	0.00
Q4	662	0.06	0.06	0.00	0.69	0.70	0.01	0.54	0.55	0.01	0.32	0.30	0.01	0.20	0.18	0.01
Highest % Company Stock	662	0.45	0.40	0.01	0.75	0.77	0.00	0.63	0.65	0.01	0.42	0.42	0.01	0.29	0.27	0.01

PANEL B: Firms with Matching Pension Data and Company Stock Holdings > $0

Quintile of % Company Stock to Plan Assets	# of Firms	Proportion of Pension Assets in Company Stock			Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock											
					Stock Held 3 Years			Stock Held 5 Years			Stock Held 10 Years			Stock Held 15 Years		
		MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
Lowest % Company Stock	253	0.03	0.03	0.00	0.65	0.68	0.01	0.51	0.53	0.01	0.28	0.28	0.01	0.16	0.14	0.01
Q2	253	0.08	0.08	0.00	0.74	0.76	0.00	0.61	0.63	0.01	0.38	0.38	0.00	0.24	0.20	0.01
Q3	253	0.19	0.18	0.00	0.73	0.74	0.01	0.59	0.61	0.01	0.37	0.37	0.01	0.25	0.22	0.01
Q4	253	0.36	0.35	0.00	0.75	0.77	0.01	0.63	0.65	0.01	0.42	0.42	0.01	0.29	0.26	0.01
Highest % Company Stock	252	0.70	0.68	0.01	0.76	0.78	0.01	0.65	0.66	0.01	0.44	0.43	0.01	0.31	0.28	0.01

Table 7

Cost to Partially-Diversified Employee Who Holds Company Stock in Proportion Equal to the Percentage of Firm's Pension Assets in Company Stock

Pension data from 1998 IRS Form 5500. The numbers in the table represent the employee's private value of company stock (i.e. value of the stock to partially-diversified investor) relative to the stock's market value. The employee's private value is the price required to compensate an employee who holds only company stock for the firm's total risk (firm-specific plus market risk) an undiversified investor must bear, estimate as the price needed in order to give the undiversified investor a Sharpe ratio equal to the market's Sharpe ratio. All inputs to this calculation use 1998 return data from CRSP. The market value of the stock uses the 12/31/98 stock price. Sample limited to firms with company stock holdings greater than zero. Assumes that employee's wealth held in company stock equals the proportion of the firm's pension assets invested in company stock.

Sorted by Quintile of Company Stock to Plan Assets (%) -- Employee Holds the Same Percentage of Wealth in Company Stock as the Plan's Percentage

Quintile of % Company Stock to Plan Assets	# of Firms	Proportion of Pension Assets in Company Stock			Cost of Employee's Risk Exposure: Stock Value to Undiversified Investor/Market Value of Stock											
					Stock Held 3 Years			Stock Held 5 Years			Stock Held 10 Years			Stock Held 15 Years		
		MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV	MEAN	MED	STD DEV
Q1: Lowest Company Stock	252	0.03	0.02	0.00	0.99	0.99	0.00	0.98	0.98	0.00	0.96	0.97	0.00	0.94	0.96	0.00
Q2	253	0.09	0.09	0.00	0.97	0.97	0.00	0.95	0.95	0.00	0.90	0.91	0.00	0.86	0.87	0.00
Q3	253	0.19	0.18	0.00	0.94	0.95	0.00	0.90	0.91	0.00	0.82	0.83	0.01	0.74	0.76	0.01
Q4	253	0.36	0.35	0.00	0.90	0.92	0.00	0.84	0.86	0.01	0.72	0.72	0.01	0.61	0.64	0.01
Q5: Highest Company Stock	253	0.70	0.68	0.01	0.83	0.85	0.01	0.73	0.76	0.01	0.56	0.58	0.01	0.43	0.44	0.01

Exhibit 3

July 8, 2005

KRISHNA RAMASWAMY

Edward Hopkinson, Jr. Professor of
Investment Banking

ADDRESS:

424 Gilpin Road
Narberth, PA 19072
(610) 949 9715

The Wharton School
3259 Steinberg-Dietrich Hall
Philadelphia, PA 19104-6367
(215) 898 6206
(215) 573 8084 (Fax)

EDUCATION

1973-1978	Stanford University, Doctoral Program in Finance, Graduate School of Business, Ph.D.
1971-1973	Duke University, M.B.A.
1966-1971	Indian Institute of Technology, Kharagpur, India B. Tech. (Honours) in Electronics & Electrical Engineering

WORK EXPERIENCE

1991-	Professor of Finance, The Wharton School.
1985-91	Associate Professor, The Wharton School; 1985-90, The Bankers Trust Term Associate Professor of Finance, The Wharton School.
1988-1989	Visiting Associate Professor, Graduate School of Business, University of Chicago.
1981-1985	Associate Professor, Graduate School of Business, Columbia University.
1982 (spring)	Visiting Associate Professor, Graduate School of Business, Stanford University.
1979-1981	Assistant Professor, Graduate School of Business, Columbia University.
1977-1979	Member of Technical Staff, Economics Research Department, Bell Laboratories, Murray Hill, NJ.

RESEARCH INTERESTS

Theoretical and Empirical Studies of the Valuation of Financial Assets, including Options and Futures Contracts; Investment Management; Risk Management; Informal Financial Markets.

ARTICLES IN JOURNALS

"A Test of the Cox, Ingersoll and Ross Model of the Term Structure" (with Michael R. Gibbons), *Review of Financial Studies*, Vol 6(3), 1993, pages 619-658.

"Does Default Risk in Coupons Affect the Valuation of Corporate Bonds?" (with In Joon Kim and Suresh M. Sundaresan), *Financial Management*, Vol 22(3), 1993, Autumn 1993, pages 117-131.

"Simple Binomial Processes as Diffusion Approximations in Financial Models," (with Daniel Nelson), *Review of Financial Studies*, August 1990, pages 393-430.

"Index-Futures Arbitrage and the Behavior of Stock Index Futures Prices," (with A. Craig MacKinlay), *Review of Financial Studies*, Summer 1988, pages 137-158.

"The Valuation of Floating Rate Instruments: Theory and Evidence" (with Suresh M. Sundaresan), *Journal of Financial Economics*, December 1986, pages 251-272.

"The Valuation of Options on Futures Contracts" (with Suresh M. Sundaresan), *Journal of Finance*, December 1985, pages 1319-1341.

"The Effects of Dividends on Common Stock Returns: Tax Effects or Information Effect?" (with Robert H. Litzenberger), *Journal of Finance*, May 1982, pages 429-443.

"On the CAPM Approach to the Estimation of a Public Utility's Cost of Equity Capital" (with Robert H. Litzenberger and Howard B. Sosin), *Journal of Finance*, May 1980, pages 369-383.

"Dividends, Short-Selling Restrictions, Tax-Induced Investor Clienteles and Market Equilibrium" (with Robert H. Litzenberger), *Journal of Finance*, May 1980, pages 469-482.

"On Distributional Restrictions for Two Fund Separation" (with Robert H. Litzenberger), *TIMS Studies in the Management Sciences*, Vol. 11, 1979, pages 99-107.

"The Effects of Personal Taxes and Dividends on Capital Asset Prices: Theory and Empirical Evidence" (with Robert H. Litzenberger), *Journal of Financial Economics*, 1979, pages 163-195.

ARTICLE IN BOOK

"Analytical Techniques Applied to Government Fiscal Risks," Proceedings of The World Bank Conference: Government at Risk, How to Manage Contingent Liabilities, May 30, 2000, (forthcoming).

"The Pricing of Derivative Assets in Foreign Exchange Markets" (with Suresh M. Sundaresan), in S. Khoury and A. Ghosh (eds.), *Recent Developments in International Banking and Finance*, Lexington Books, Lexington, MA, 1987.

DOCTORAL THESIS

"The Loan Operations of Financial Intermediaries and the Valuation of Secondary Financial Claims", Stanford University, 1978.

WORKING PAPERS

"Looking for Spot Prices in the Presence of Futures" (with Patrick J. M. Waldron).

TEACHING EXPERIENCE

At Columbia University

Investment Management
Seminar on Options and Financial Futures
Doctoral Seminar in Empirical Methods

At Stanford University

Seminar on Investments
Management of Financial Institutions

At Wharton

Introductory Ph.D. Course in Financial Economics
Advanced Study Projects on Options and Futures Markets
Speculative Markets (Options and Futures Markets)
Financial Engineering
Financial Analysis

PROFESSIONAL ACTIVITIES

Board of Directors, American Finance Association, Elected to 3 year term, 1995-98

Associate Editor, *The Review of Financial Studies*, 1987-90

Research Coordinator, The Institute for Quantitative Research in Finance, from 1979 to 1988.

Referee for:

Journal of Finance, Journal of Financial Economics,
American Economic Review, Review of Economic Studies,
Journal of Financial and Quantitative Analysis,
Quarterly Journal of Economics, Review of Financial Studies.

Executive Education Programs (Administered by Wharton):

Pension Funds & Money Management
Security Industry Association
Dean Witter Program in Investments
Association of Investment Management Sales Executives (AIMSE)
Nomura Investment Management Program (Singapore)
Seminar on Options and Futures (Bombay)

Prepared and Taught Training Programs in Risk Management for:

Prudential Insurance Company
The Coffee Federation of Colombia (Bogota)
Ecopetrol (Colombia's State-owned Oil Corporation)
ARPEL, The Latin American Oil Companies' Association
Morgan Stanley Dean Witter
The World Bank

Consultancies (among others):

Former and Current Bell System Operating Companies (Cost of Capital Determination)
Bankers Trust Company (Risk Measurement & Options Strategies)
The International Monetary Fund (Pension Management)
ARCO (Risk Management)
Hershey Foods (Value-at-Risk & Risk Management)
State Street Bank (Advisory Council)